NICC ND 1604 V3.1.1 (2012-03)

Specification of the

Access Network Frequency Plan

applicable to transmission systems

connected to the KCH Access Network

Issue 3

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Contents

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Foreword

This document has been produced by the NICC Working Group on Digital Subscriber Line (DSL) – Spectrum Management Plan. Representatives from Network Operators, switch and terminal equipment manufacturers, test laboratories, and Ofcom participated in the Working Group.

This issue of the ANFP is a revision of the KCH ANFP, Issue 2 (ND1604:2006/09) [8] following unanimous agreement within the NICC DSL Working Group to revise the ANFP in such a way as to enable the use of the 998ADE17-M2x-A VDSL2 band plan in Part B and Part C. 998ADE17-M2x-A is defined in G.993.2 Amendment 1 Annex B [23]. The methodology behind the development of this ANFP conforms to that of the BT ANFP NICC ND 1602:2002/11[6].

This issue of the ANFP is backwards compatible with the previous issue.

1   Scope

The present document defines the Access Network Frequency Plan (ANFP) applicable to transmission systems connected to the KCH access network. It is applicable to the KC access network provided using unscreened twisted metallic pairs within the geographic area defined by annex B of the licence granted to KCH on the 30th November 1987 under section 7 of the Telecommunications Act 1984 and amended by SI 2455 1999. It does not however apply to the access network provided by optical fibre.

To ensure the prevention of undue interference between transmission systems used on different metallic pairs in the same access cable, transmission systems (whether provided by KCH, Local Loop Unbundling Operators (LLUO) or customers) connected to metallic pairs of the KCH access network need to conform to this specification. This specification is applicable to all KCH switched and leased line analogue services.

Note.   This specification only considers the limits relevant to control of interference between transmission systems on different lines. There may be other limits also applicable, and conformance to this specification does not necessarily satisfy those limits. Such other limits may include, for example, safety limits on line voltages (see EN 60950 [16]), RFI balance requirements, and line sharing limits.

This specification supersedes ANFP Issue 2 specification (ND1604:2006/09) [8].

Figure 1 shows the points in the KCH access at which the ANFP applies. The equipment configurations illustrate dedicated (i.e. not shared) and shared, full loop Metallic Path Facility (MPF) and sub-loop scenarios. The location of equipment (i.e. modems and splitters) at the Main Distribution Frame (MDF) site and near the Sub Loop Connection Point (SLCP), and the wiring arrangements for the splitter filters, are illustrative only.

The ANFP applies to the signal levels at the actual point of connection to the KCH metallic access network i.e. at the MDF, Sub-loop Distribution Frame (SDF) or Network Termination Point (NTP).
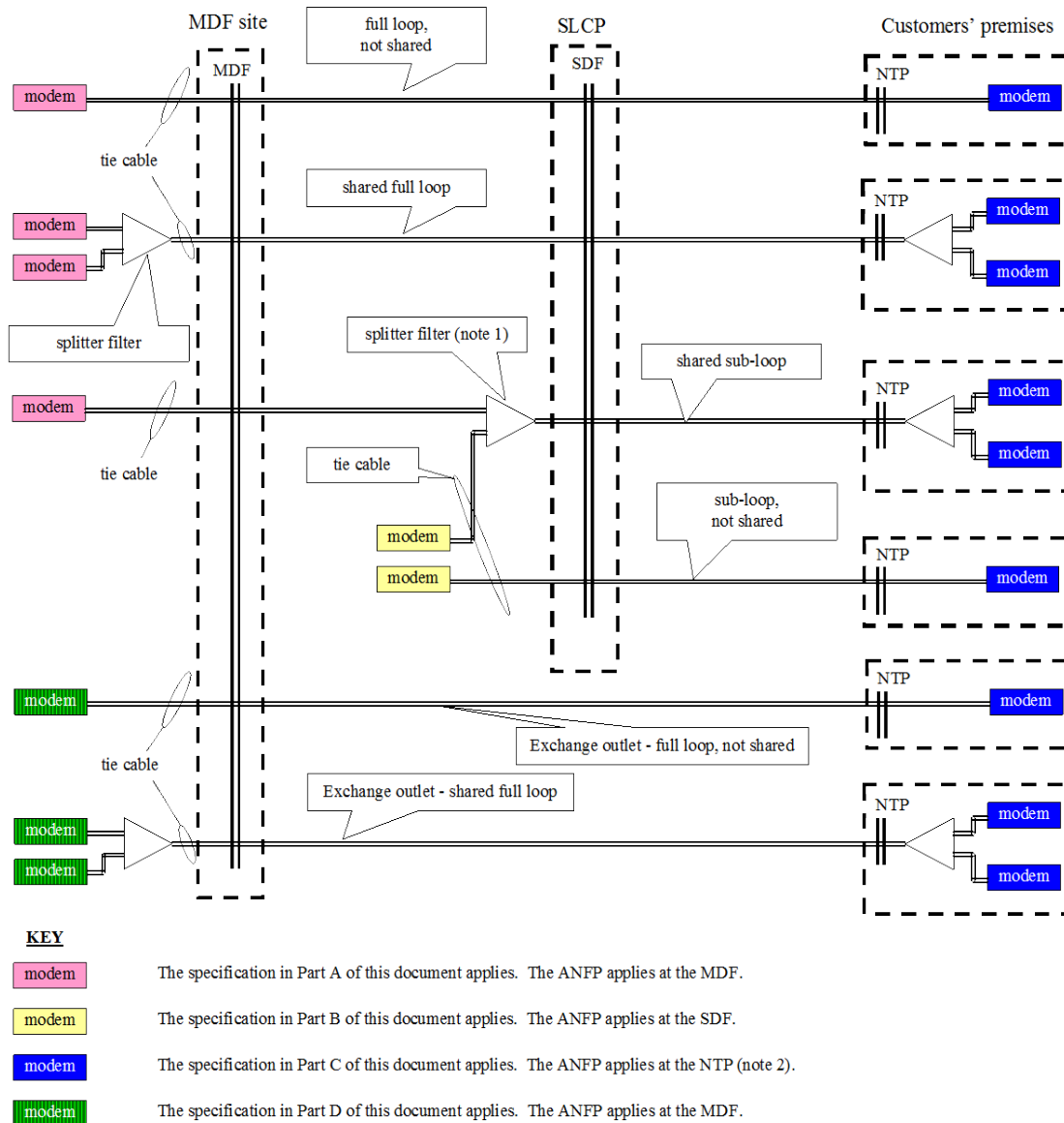
Figure 1 – Application of the ANFP

NB. This figure shows the points in the KCH metallic access network at which the ANFP applies. The location of equipment (i.e. modems and splitters) at the MDF site, SLCP and customer premises, and the wiring arrangements for the splitter filters are illustrative only and do not necessarily represent actual implementation.

The limits specified in the ANFP apply when measured according to the associated reference measurement technique given in section 4.2.2 and section 6.

Note 1.   It is envisaged that some installations may share the sub-loop, that is concurrently using the whole loop for some signals, the sub-loop for others, and perhaps merging the signals onto the sub-loop by splitter filters at each end of the sub-loop. Providing the SLCP splitter filter equipment does not amplify signals, and blocks signals originating from the transmission equipment connected to the sub-loop at the SLCP from the remainder of the full loop (i.e. in the direction towards the MDF), its signal outputs are anticipated to be acceptable.

Note 2.   It is recognised that a customer's installation may comprise wiring and a number of items of customer premises equipment (CPE). Further, there may be other items of equipment between the customer's installation and the metallic pair (i.e. on the network side of the NTP), e.g. filters

or active line termination equipment. The limits in this ANFP apply at the interface to the metallic pair of the KCH access cable.

The ANFP defines the maximum signal power levels that may be transmitted into the KCH access network at the various points of connection with the objective of managing the crosstalk interference. It does *not* directly define what xDSL systems may be connected to the KCH access network or what bandwidth services may be deployed. Guidance on what ANFP-compliant xDSL systems may be connected to the KCH access network is given in Part E of this document.

2   References

2.1   Normative references

[1]   TBR 21
           "Terminal Equipment (TE); Attachment requirements for pan-European approval for
           connection to the analogue Public Switched Telephone Networks (PSTNs) of TE
           (excluding TE supporting the voice telephony service) in which network addressing, if
           provided, is by means of Dual Tone Multi Frequency (DTMF) signalling"
           January 1998
           may be downloaded from http://www.etsi.org/

[2]   EN 301 437
           "Terminal Equipment (TE); Attachment requirements for pan-European approval for
           connection to the analogue Public Switched Telephone Networks (PSTNs) of TE
           supporting the voice telephony service in which network addressing, if provided, is by
           means of Dual Tone Multi Frequency (DTMF) signalling"
           June 1999
           may be downloaded from http://www.etsi.org/

[3]   EG 201 121
           "A guide to the application of TBR 21"
           February 2000
           may be downloaded from http://www.etsi.org/

[4]   TR 103 000-2-1
           "Advisory Notes to Standards Harmonizing Terminal Interface; Generally applicable
           Advisory Notes; Modification to sending spectral density requirements"
           February 2002
           may be downloaded from http://www.etsi.org/

[5]   BS6305:1992
           "General requirements for apparatus for connection to public switched telephone
           networks run by certain public telecommunications operators"
           1992
           available from BSI – see http://bsonline.techindex.co.uk/

2.2   Informative references

[6]   NICC ND 1602:2002/11
            Issue 2; November 2002
            "Specification of the Access Network Frequency Plan applicable to transmission systems
            used on the BT Access Network"
            Oftel Technical Requirement OTR004:2002 Issue 2
            available at
            http://www.ofcom.org.uk/static/archive/oftel/ind_groups/nicc/Public/interconnectstandard
            s/isc.htm

[7]   ITU-T Recommendation G.992.5 (2009) "Asymmetric Digital subscriber Line (ADSL)
            transceivers – Extended Bandwidth ADSL2 (ADSL2+)
            January 2009
            Available through http://www.itu.int/publications/default.aspx

[8]   NICC ND 1604:2006/09
            "Specification of the Access Network Frequency Plan applicable to transmission systems
            used on the KCH Access Network"
            Issue 2
            September 2006
            available at http://www.niccstandards.org.uk/publications/index.cfm

[9]   "Essential requirements for terminal equipment intended for Connection to unstructured
            digital leased circuits of the public Telecommunications network using a CCITT
            Recommendation G.703 interface at a rate of 2048 kbit/s with a 75 Ω unbalanced
            presentation"
            PD 7024: 1994
            available from BSI, see URL http://www.bsi-global.com/

[10]   ADLNB WG-2 (chairman C. P. Raymont)
            "Guidance Notes on Measurement Uncertainty"
            GN/WG2/1 issue 3 dated 19 March 1998
            In the methods of [10] there is separation between requirements specification and the
            capabilities of any particular test house. ADLNB has been incorporated into a larger
            body, the "R&TTE Compliance Association" (see http://www.rtteca.com/)

[11]   NOTIFICATION UNDER SECTION 48(1) OF THE COMMUNICATIONS ACT 2003
            Notification setting general conditions under section 45 of the Communications Act 2003
            available at
            http://www.ofcom.org.uk/static/archive/oftel/publications/eu_directives/2003/cond_final0
            703.pdf

[12]   The Crown
            "The Radio Equipment and Telecommunications Terminal Equipment Regulations 2000"
            UK Statutory Instrument 2000 No. 730
            published on 13 March 2000
            Authoritative version: ISBN 0 11 098835 3
            Internet version: http://www.hmso.gov.uk/si/si2000/20000730.htm
            This transposes the EC directive 99/5/EC into UK law. There is a discussion of the
            process at http://www.dti.gov.uk/strd/rtte.html

[13]   "General requirements for the competence of testing and calibration laboratories"
            ISO/IEC 17025: 1999
            available at http://www.standardsinfo.net/isoiec/stdcat.html

[14]   ATIS NIPP NAI
            "Spectrum Management For Loop Transmission Systems"
            T1.417-2003
            may be downloaded from http://www.atis.org/doccenter.shtml

[15]   ITU-T Recommendation G.992.1 Asymmetric Digital Subscriber Line (ADSL)
            Transceivers
            July 1999
            Available through http://www.itu.int/publications/default.aspx

[16]   BS EN 60950-1:2002
            "Information Technology Equipment – Safety; General Requirements"
            2002
            available from BSI – see http://bsonline.techindex.co.uk/

[17]   NICC ND1404:2005/07
            "Guidelines for any inter-network interference issues between DSL operators in the same
            access network"
            Issue 2, March 2002
            available at http://www.niccstandards.org.uk/publications/index.cfm

[18]   NICC ND1403:2005/07
            "Guidelines for any external network interference issues to radio users due to radiated
            emissions from fixed public networks"
            Issue 1, March 2002
            available at http://www.niccstandards.org.uk/publications/index.cfm

[19]   ITU-T Recommendation G.993.2 (02/2006)
            Very high speed digital subscriber line transceivers 2 (VDSL2)
            available through http://www.itu.int/rec/T-REC-G.993.2/en

[20]   ITU-T Recommendation G.993.1
            "Very high speed digital subscriber line"
            (06/2004)
            available at http://www.itu.int/rec/T-REC-G.993.1-200406-I/en

[21]   NICC ND1604:2012/3.1.1 Spreadsheet
            "Spreadsheet of PSD Mask Data Definition given in Sections A.3, B.4 and C.4 of
            ND1604:2012/3.1.1 "
            available at http://www.niccstandards.org.uk/publications/index.cfm

[22]   Broadband Forum
            TR-114 "Vdsl2 Performance Test Plan" and TR-115 "Vdsl2 Functionality Test Plan."
            available at http://www.broadband-forum.org

[23]   ITU-T Recommendation G.993.2 (2006) Amendment 1
            " Very high speed digital subscriber line transceivers 2 (VDSL2) Amendment"
            (04/2007)
            available at http://www.itu.int/rec/T-REC-G.993.2-200704-I!Amd1/en

[24]   ARTICLES OF ASSOCIATION of NICC STANDARDS LIMITED
            available at http://www.niccstandards.org.uk/about/files/articles-2010.pdf?type=pdf

[25]   ITU-T Recommendation G.992.2 Splitterless Asymmetric Digital Subscriber Line
            (ADSL) Transceivers July 1999
            Available through http://www.itu.int/publications/default.aspx

[26]   ITU-T Recommendation G.992.3 Asymmetric Digital Subscriber Line Transceivers
            (ADSL2)January 2005
            Available through http://www.itu.int/publications/default.aspx

[27]   ITU-T Recommendation G.992.4 Splitterless Asymmetric Digital Subscriber Line
            Transceivers (Splitterless ADSL2)
            January 2005
            Available through http://www.itu.int/publications/default.aspx

[28]   ITU-T Recommendation G.991.2 Single-pair high-speed digital subscriber line (SHDSL)
            transceivers
            December 2003
            Available through http://www.itu.int/publications/default.aspx

[29]   Report on the Mutual Compatibility of Transmission Systems used in Public Access &
            Private Networks - ND1506:2004/11 (available on NICC website at
            http://www.niccstandards.org.uk)

3   Definitions

For the purposes of the present document, the following abbreviations apply:

ADSL	Asymmetric Digital Subscriber Line
ADSL2+	A variant of ADSL defined in ITU-T Recommendation G.992.5[7]
ANFP	Access Network Frequency Plan
ANFP-S	Access Network Frequency Plan for the Sub-loop
ATIS	Alliance for Telecommunications Industry Solutions 1200 G Street, NW, Suite 500 Washington, DC 20005 USA Tel +1 202-628-6380 Homepage http://www.atis.org
BT	British Telecommunications plc *(bridged taps are not discussed in this document)*
CAL	Cabinet Assigned Loss, a parameter that describes the electrical length of the cables between an MDF site and a connected SLCP.
CCITT	The International Telegraph And Telephone Consultative Committee, part of the ITU
CPE	Customer Premises Equipment
DC	Direct Current
DP	Distribution Point – the final flexibility point in the KCH access network before the line reaches its customer
DSL	Digital Subscriber Line - any of the modem technologies that send high speed data over metallic telephone pairs. A DSL line has a dedicated modem at each end of the physical wire pair; typically one of these is in the exchange
DSL WG	Digital Subscriber Line Working Group A Working Group under NICC
DSLAM	DSL Access Multiplexer, the equipment responsible for supplying DSL services at the MDF Site or SLCP.
DTI	Department of Trade and Industry
DTMF	Dual Tone Multi Frequency, a signalling system used by telephones.
EMC	Electromagnetic Compatibility

EO	Exchange Outlet (lines), local loops that do not pass through a cabinet and which therefore are not accessible via an SLCP.
ETSI	European Telecommunications Standards Institute
EUT	Equipment Under Test.
HDF	Handover Distribution Frame
HDSL	High bit rate Digital Subscriber Line
IEC	International Electrotechnical Commission, an international standardisation body
ISO	International Organisation for Standardisation
ITU	International Telecommunications Union, an international standardisation body
KCH	Kingston Communications (Hull), Member of the KCOM Group
LF	Low Frequency, in this connection usually meaning <150kHz.
LLUO	Local Loop Unbundled Operator
MDF	Main Distribution Frame
MPF	Metallic Path Facility - a term used for the loop available to LLUOs
NICC	Network Interoperability Consultative Committee - a committee of UK industry; homepage: http://www.nicc.org.uk
NTE	Network Termination Equipment, equipment containing the NTP, often a white socket on the wall of a customer's premises.
NTP	Network Termination Point (The legal demarcation between the network provider's cabling and the customer's in-house wiring. On a telephone line this point often has a master socket or NTE)
POTS	Plain Ordinary Telephone Service - analogue voiceband telephony
PSD	Power Spectral Density
RBW	Resolution BandWidth
RE&TTE	Radio Equipment and Telecommunications Terminal Equipment - [12]
RFI	Radio Frequency Interference
SDF	Sub-loop Distribution Frame

SDSL	Symmetric single pair high bitrate Digital Subscriber Line A term used in ETSI to refer to SHDSL. This should not be confused with the USA use of the term 'SDSL' which refers to DSL systems similar to HDSL.
SHDSL	Single-pair High-speed Digital Subscriber Line
SLCP	Sub-Loop Connection Point
T1E1.4	T1E1.4 was the name of the ATIS working group concerned with DSL for North America. This working group has been renamed NIPP-NAI. Please see URL for further information http://www.atis.org/0050/nai.asp
TE	Terminal Equipment, usually referring to POTS CPE
TU-C	Terminal Unit-Central, the transmission equipment normally at the MDF site or SLCP.
TU-R	Terminal Unit-Remote, the transmission equipment normally at the customer premises.
VDSL	Very high speed Digital Subscriber Line
xDSL	any variant of DSL modem e.g. ADSL, HDSL, SHDSL or VDSL

4   ANFP Specification

For each point of application of the ANFP defined in Figure 1, the ANFP is defined by:

> A Power Spectrum Density (PSD) mask (or set of PSD masks) - see section 4.1, and

> By voice-band specification - see section 4.2.

In addition at the NTP defined in Figure 1, the ANFP is defined by:

> For systems using part C.3.2 an average power limit – see section 4.3

For frequencies at and below 200 kHz, equipment compliant to this ANFP must either meet the requirements defined in section 4.1 or section 4.2. For frequencies above 200 kHz, the requirements of section 4.1 apply. When meeting the requirements of section 4.1 from the NTP application point and section C.3.2, the requirements of section 4.3 also apply.

All previous versions of the document are deprecated and all systems must comply with ANFP version 3.

Note.   Equipment that has been approved under the UK terminal equipment approval regime that existed prior to the implementation of the RE&TTE Directive [12] is deemed to be compliant to this ANFP.

4.1   PSD Mask Definition

4.1.1   PSD Mask

For each point of application of the ANFP defined in Figure 1, a PSD mask (or set of PSD masks) is defined. Table 1 lists the 4 points of ANFP application and shows where in this document the PSD mask(s) is specified.

Point of Application of the ANFP	PSD Mask specification
MDF (at an MDF site/exchange) connected to metallic access network cables routed to an NTP via a SLCP.	Part A
SDF (as a sub-loop connection point)	Part B
NTP (at the customer's premises)	Part C
MDF Exchange Outlet (at an MDF site/exchange) connected to metallic access network cables routed directly to an NTP without a SLCP included in the routing and not sharing a cable sheath containing cables routed via a SLCP.	Part D

Table 1 - Interface Categories

4.1.2   Test Specification

The test specification given in section 6 applies.

4.2   Alternative Voice-band Specification

4.2.1   Requirements

For frequencies at and below 200 kHz, compliance to this ANFP for all interface categories may be demonstrated by conformance to the requirements in this section as an alternative to meeting the requirements of section 4.1.

Note 1.   The requirements in this section are drawn from ETSI voice-band CPE standards[1]. However, any type of equipment may use these requirements (and associated tests) instead of the requirements in section 4.1 to demonstrate compliance to this ANFP.

Equipment compliant to this ANFP under this section shall meet the requirements of the following Clauses of TBR 21 [1] (Note 2):

- Clause 4.7.3.1 (Mean sending level);

- Clause 4.7.3.2 (Instantaneous voltage);

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1 Various technical standards have set voiceband limits for CPE but the most recent were TBR 21 [1], EN 301 437 [2], EG 201 121 [3] and TR 103 000-2-1 [4] all published by ETSI.

- Clause 4.7.3.3 (Sending level in a 10 Hz bandwidth) as modified by TR 103 000-2-1 [4] (See Notes 3 and 4);

- Clause 4.7.3.4 (Sending level above 4.3 kHz) as modified by TR 103 000-2-1 [4];

- Clause 4.8.2.2.1 (DTMF Absolute Sending Levels)   (See Note 5).

Note 2.   The intent of these requirements is to control the level of crosstalk. TBR21 deals with other aspects but only those requirements relating to the control of crosstalk have been included in this ANFP.

Note 3.   The requirements of this clause below 100 Hz do not apply in this ANFP.

Note 4.   As described in EN 301 437 [2] Annex C, it is not necessary to test the requirements of this clause if the terminal is a voice terminal (e.g. has a handset) and requires voice stimulation to perform the test.

Note 5.   Only applicable if the equipment has a DTMF sender.

Infrequent and short duration signals at levels higher than those specified in this section are permitted from equipment used for MPF maintenance or from equipment connected to the MDF and/or SDF and used for management and maintenance of voice-band services (e.g. the howler signal – see BS6305 [5], Appendix C.4).

4.2.2   Test Specification

Conformance to the requirements specified in section 4.2.1 shall be demonstrated by using the following tests specified in TBR 21 [1]. The test methodology specified in TBR21 shall be used for non-voice stimulated terminals and the test methodology specified in Advisory Note AN 13R01 given in EG 201 121 [3] for voice stimulated terminals.

- Clause A.4.7.3.1 (Mean sending level);

- Clause A.4.7.3.2 (Instantaneous voltage);

- Clause A.4.7.3.3 (Sending level in a 10 Hz bandwidth)   (Note 1);

- Clause A.4.7.3.4 (Sending level above 4.3 kHz)

- Clause A.4.8.2.2 (Signalling Levels) (Note 2).

Note 1.   As described in EN 301 437 [2] Annex C, it is not necessary to test the requirements of this clause if the terminal is a voice terminal (e.g. has a handset) and requires voice stimulation to perform the test.

Note 2.   Only applicable if the equipment has a DTMF sender.

4.3   Average PSD Definition

For the NTP application point of the ANFP defined in Figure 1, when complying to the requirements of section 4.1 and the PSD masks from section C.3.2 the following definition of normalised average PSD must be applied.

4.3.1   Normalised Average PSD

Let the network operator have N lines deployed at an SLCP, with each line n, $n = 1, 2, ... N$, having electrical length $kl0_n$ between the SDF and the NTP. Denote the PSD mask defined in Section C.3.1, on line n as $umask_n(f)$ dBm/Hz, where on line n, $kl0 = kl0_n$. The PSD mask that is actually complied with on line n is

denoted as $amask_n(f)$ dBm/Hz. Then, for all frequencies f between 3.74 and 5.25 MHz and between 8.40 and 12.10 as defined in Table C.2,

$$amask_n(f) < umask_n(f) + 5 \text{ dB, for all n}$$

and,

$$10 Log_{10}\left(\frac{1}{N} \sum_{n=1}^{N} 10^{(amask_n(f) - umask_n(f))/10} \right) \leq -2 \text{ dB}$$

for each network operator at that SDF.

$amask_n(f)$ is defined by Table C.2. The variables A1, B1, A2, and B2 in Table C.2 are set such that the constraints of Section C.3.2 are satisfied.

4.3.2   Test Specification

This section is for further study and relates to section C.3.2

5   ANFP Conformance and Interference Management

To successfully manage crosstalk interference on the KCH metallic access network, all equipment connected to the KCH metallic access network shall comply with the ANFP. Hence this includes:

- KCH equipment connected to the metallic access network;

- Network operator equipment connected to a Metallic Path Facility;

- Customer equipment connected to an analogue NTP that is either directly or indirectly connected to the KCH metallic access network, to the extent that its behaviour is relevant to conditions present on the metallic access network itself.

The ANFP is enforced through the measures described below.

5.1   Enforcement on Network Operators

The contract between KCH and network operators for provision of Metallic Path Facility requires both parties to comply with the ANFP. Demonstration of compliance is via a system of self-declaration.

Note 1.   A Test Specification (section 4.2.2 and section 6) has been defined to test telecommunications equipment for conformance to the ANFP. KCH requires network operators to ensure that Compliant Equipment to be connected to the Metallic Path Facility is tested, using the Access Network Frequency Plan Test Specification for compliance to the Access Network Frequency Plan. However it is up to the network operator whether it undertakes conformance testing itself or requires the supplier or a third party to undertake it.

Whatever way conformance is demonstrated, the responsibility for the declaration and the correctness of that declaration resides with the network operator. In the event of a dispute on the conformance of a piece of telecommunications equipment, the Test Specification (section 4.2.2 and section 6) will be used.

Note 2.   As NTEs for analogue circuits are typically transparent to the signals generated by customer equipment, a customer's equipment that is non-compliant to the ANFP may cause undue interference on the KCH access network. It is the responsibility of the network operator providing service to that customer to resolve any interference issues caused by non-compliant customer equipment.

5.2   Enforcement on Customer Equipment

The essential requirements that customer equipment must meet before that equipment is allowed to be connected to any public network is defined in the UK implementation of RE&TTE directive [12]. For customer equipment to be connected to a public fixed network, the essential requirements are currently limited to safety and EMC.

General Condition 3 (of the General Conditions of Entitlement applicable to Communication Providers [11]) requires network operators[2] to maintain the integrity of their network. Further, General Condition 3.2 requires network operators to declare the conditions under which access to the network will be restricted or removed in order to protect the integrity of the network.

Hence network operators employing MPFs should declare that conformance to the ANFP by customer's equipment is a requirement for network integrity and that access to the network may be restricted if ANFP conformance is not maintained. Such a declaration should be made in the network operator's interface specifications for the relevant services. Publication of these interface specifications is a requirement under Article 4(2) of the RE&TTE Directive.

Where a customer's installation causes, or can reasonably be foreseen to cause, harmful interference to transmission systems used on different metallic pairs in the same (or other) access cable(s), KCH may require that the interference be prevented, for instance by means of mitigation measures (e.g. by the addition of a filter), or by requesting authorisation for disconnection under Article 7.4 of the RE&TTE directive [12] or other relevant powers.

Note 1.   Although, from a regulatory perspective, it is not a mandatory requirement for customer premises equipment (CPE) to conform to this ANFP, since this would be contrary to the RE&TTE directive [12], it is strongly recommended that CPE does conform to this ANFP.

Note 2.   This specification only considers the limits relevant to control of interference between transmission systems on different lines. There may be other limits also applicable, and conformance to this specification does not necessarily satisfy those limits. Such other limits may include, for example, safety limits on line voltages (see BS EN 60950 [16]), RFI balance requirements, and line sharing limits.

5.3   Enforcement on Equipment installed prior to the publication of the ANFP

The ANFP has been developed taking account of existing equipment that has been deployed in significant volume. There may exist equipment deployed in relatively low volumes that does not comply with the ANFP e.g. existing CPE equipment approved for connection to analogue baseband circuits. It is intended that the ANFP should not be retrospectively applied to such equipment and such equipment will be allowed

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2 this means all network operators, not just the network owner i.e. KCH.

to continue working provided it does not cause undue interference to other systems. If one of these pre-ANFP systems is found to cause excessive interference, the resolution of the interference problem will be handled on a case-by-case basis.

If in the future the ANFP is amended, resulting in equipment that would have been compliant under the superseded edition of the ANFP not being compliant with the amended version of the ANFP, then the handling of such equipment needs to be taken into account as part of the considerations concerning the amendment of the ANFP.

5.4   Interference Management Guidelines

The DSL Working Group has produced guidelines on the steps that would normally be considered reasonable for an operator to take to try and resolve an interference complaint. Separate guidelines covering inter-network [17] and external [18] interference have been published.

For inter-network interference, the policy has been adopted to try to eliminate all outside causes of a reported problem before expensive investigation of the multiple systems within a cable is undertaken. That may of necessity involve a number of operators within an MDF site and could cause the interruption of service to a potentially large group of their customers.

More details of these measures are given in the Inter-network Interference Guidelines 1 but this would involve for example: -

- Questioning the customer concerning what other equipment is connected to their line.

- Checking that the reduction in service reported by the customer is a valid complaint by:
    - o Reviewing against the deployment rules to check that they have been followed.
    - o Checking that the performance achieved does not meet that specified in the service level agreement. It is possible that higher rates than those predicted under the crosstalk noise environment defined by the ANFP could be achieved when the cable was lightly loaded with xDSL traffic but that this reduces as more users are added.

- Changing the DSLAM and Customer modems.

- Possibly checking the MPF for any significant change from its initial measured parameters.

- It has been recognised that managing interference problems will only work if there is co-operation and trust between the operators involved. This will also require the rapid exchange of information concerning the technical details of the services being passed on pairs within an affected cable where the initial investigations, outlined above, fail to find the source of the problem.

6   PSD Mask Test Specification

This test specification defines tests to be used in a laboratory environment to determine conformance of telecommunications equipment to the requirements specified in the main body of the ANFP.

The tests here only relate to the requirements of the ANFP. Other limits, for example those related to safety, line balance, and interactions between systems on the same pair are out of scope.

Note 1.   This test specification is for use in a laboratory environment only.

Note 2.   Strictly the ANFP specifies limits at the ports of the access network, not for individual equipment per se. This specification is to verify that deployed equipment would not violate the ANFP.

Note 3.   Section 6.5 of this document is based on the equivalent specification contained in the ATIS
            standard "Spectrum Management For Loop Transmission Systems" [14]. The use and
            reproduction of extracts from that standard is provided with kind permission of ATIS (Alliance
            for Telecommunications Industry Solutions).

6.1   Reference Model

The ANFP limits the power that may be injected into a metallic pair in the KCH access network at three
interfaces, the MDF, SDF and NTP.

In the case of Local Loop Unbundling, there is another interface, the HDF (Handover Distribution Frame
which is the equipment that terminates the tie cables). Managing crosstalk interference in the cabling
between the HDF and the MDF or HDF and SDF is the responsibility of the network operator(s) using that
cabling. The ANFP is applied at the MDF and SDF.
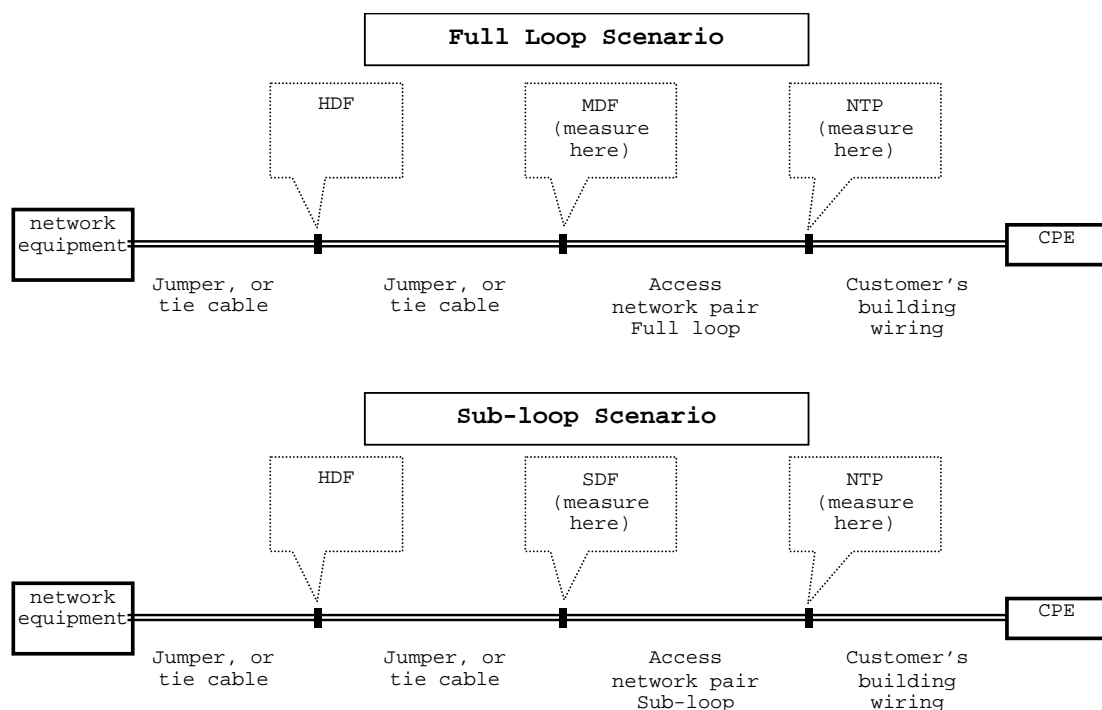
Figure 2: Network Interfaces to which the ANFP applies

6.2   Test Configuration

The equipment under test ("EUT") will comprise the end equipment, any ancillaries that are always present[3], and a load to represent the access network.

The equipment at each end is tested independently.

Equipment will be tested in all the modes that the operator proposes to use. Other modes, perhaps provided for use in other countries, need not be tested.
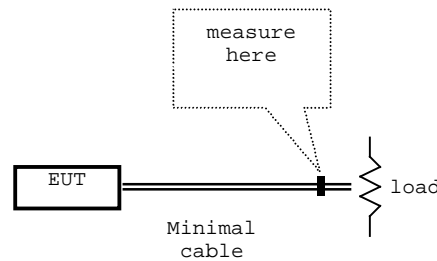
Figure 3: Test configuration

The limits applicable to each point of application of the ANFP (i.e. MDF, SDF, NTP) are different and for the SDF and NTP vary depending on the Cabinet Assigned Loss and line categorisation respectively. An EUT intended for connection at SDF or NTP shall be tested against the maximum, minimum and one, mid-level PSD mask chosen from the set of applicable PSD masks defined in Part B and Part C respectively.

6.3   Measurement Conditions

The prospective operator shall declare his deployment intentions for the equipment under test. This determines which modes the equipment is tested in, and which ANFP mask(s) it is tested against.

The measurement conditions below are derived from ISO/IEC 17025 [13], "Guidance Notes on Measurement Uncertainty" [10], and PD 7024 [9].

6.3.1   Estimation of uncertainty of measurement

A laboratory or facility performing testing shall have and shall apply procedures for estimating uncertainty of measurement.

When estimating the uncertainty of measurement, all uncertainty components which are of importance in a given situation shall be taken into account using appropriate methods of analysis.

The test report or compliance statement shall include the uncertainty of measurement.

Note 1.   It is recommended that measurement uncertainty be calculated as defined in [10].

Note 2.   Sources contributing to uncertainty include, but are not necessarily limited to, the reference standards and reference materials used, methods and equipment used, properties and condition of the item being tested.

6.3.2   Compliance

Compliance to the requirements of this standard shall be reported on the shared risk principle as specified in [10] figures 1 to 3.

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3 For example splitter filters, and connecting leads which are part of the kit supplied with the end equipment

Compliance to these requirements shall be determined either by use of the test methods defined within this standard or by use of test methods and results obtained from other standards accompanied with a technical justification detailing how such results demonstrate compliance to this standard.

Note.   The requirements of this standard are derived from a number of technology-specific standards. In many cases it will be sufficient to test equipment to the specific design standard for their technology, and make a compliance statement to this standard following technical review of the results. The technical review should not be omitted as some options of specific technologies are excluded from these requirements and would present non-compliant results to this standard.

6.3.3   Calibration of test equipment

Equipment and its software used for testing shall be capable of achieving the accuracy required. Calibration programs shall be established for values of the instruments where these properties have a significant effect on the result

The equipment shall be calibrated to provide a minimum 95% confidence level in the accuracy of the results.

6.3.4   General Conditions for Test

If the supplier has specified a temperature range within which the TE will be operational, the testing shall be performed within this range. The testing shall be performed within the temperature range 15 ºC to 25 ºC, if consistent with the temperature range declared by the supplier.

If the supplier has specified a humidity range within which the TE will be operational, the testing shall be performed within this range. The testing shall be performed within the humidity range 45% to 75%, if consistent with the humidity range declared by the supplier.

For equipment that is directly powered from the mains supply all tests shall be carried out within ±5% of the normal operating voltage.

If the equipment is powered by any other means and those means are not supplied as part of the equipment, (e.g. batteries, stabilised AC supplies, DC etc.) all tests shall be carried out within the power supply limit declared by the supplier.

If the power supply is AC the tests shall be conducted within ±4% of the stated UK supply frequency (50 Hz) and not at any range specified by the supplier.

Note.   In general, equipment being tested for conformance to Part B (the SDF PSD mask) will be housed in street furniture. The environmental conditions obtained in street furniture may vary considerably depending on the type used (e.g. cabinet or footway box) and whether any environmental control is provided. The purpose of the above test conditions is to ensure that the equipment conforms to the requirements of this specification when operating in the environment for which it is designed. It is the network operator's responsibility to ensure that the equipment is housed in an environment that is maintained within the designed operating conditions of the equipment.

6.3.5   Independence of polarity

The equipment shall conform to this specification independent of the polarity of the pair it uses. For a line-powered EUT the tests shall be carried out twice, once with each polarity of connection of the power supply.

6.4   PSD Conformance Testing Methodology

This section specifies the conformance testing methodology to be used to demonstrate compliance to the requirements defined in section 4.1. The conformance testing methodology in this clause is derived from

"Spectrum Management For Loop Transmission Systems" [14]. It shall be used to determine compliance with the signal power limitations requirements in the ANFP.

Note.   Where this ANFP makes no requirements (e.g. longitudinal output, non-stationary signals), this document specifies no tests.

6.4.1   PSD measurement procedure

The limits applicable to a particular end equipment are discussed above, in section 6.2.

6.4.2   Test circuit for PSD measurement

A test set-up, as pictorially shown in Figure 4, shall be used for measuring PSD. Examples of specific embodiments of this test set-up are shown in Figure 5 and Figure 6. The difference between Figure 5 and Figure 6 is the input impedance of the instrument to be connected to V_{out}; Figure 5 assumes a high-impedance port, Figure 6 assumes a 50 Ω port (typical for a spectrum analyzer). The PSD may be tested while line powered or locally powered as required by the intended application of the EUT.
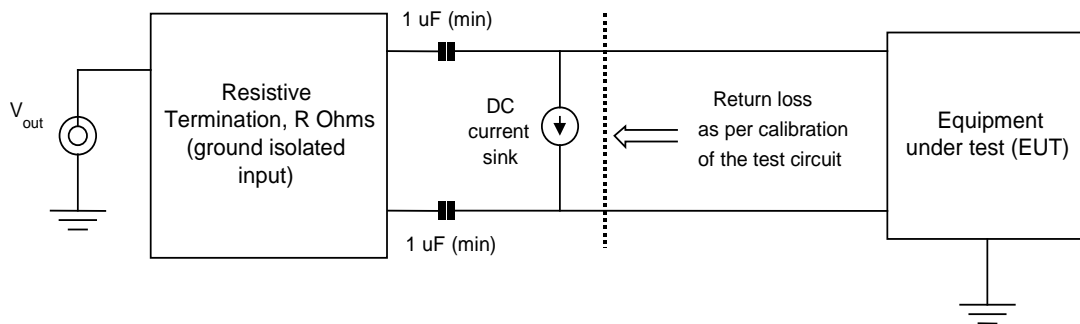
Figure 4 - PSD measurement set-up
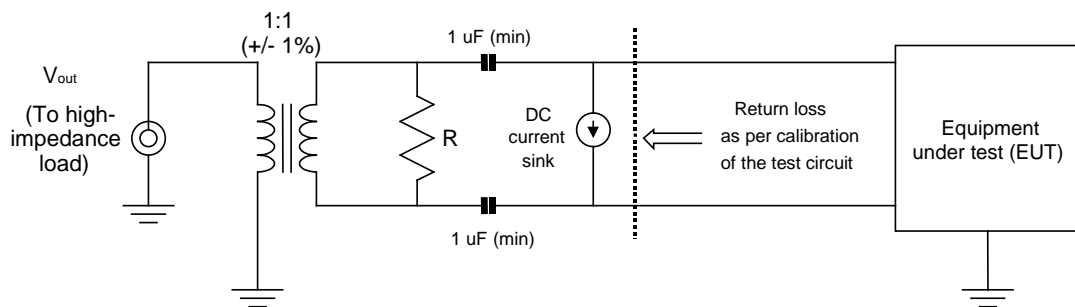
Figure 5 - Example PSD measurement set-up for high impedance instrument
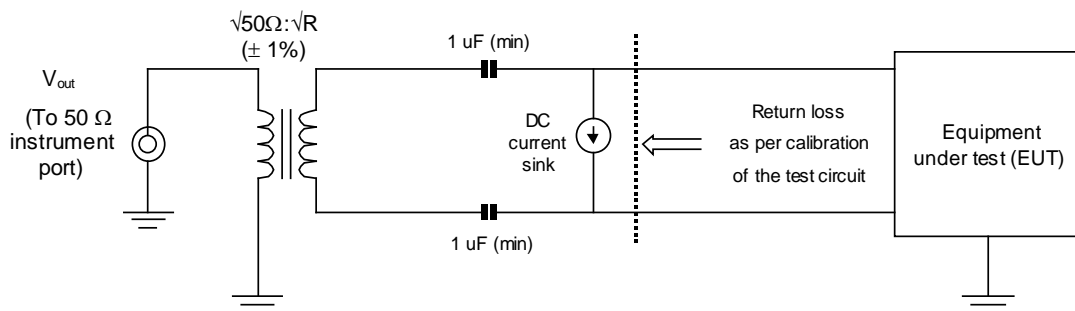
Figure 6 - Example PSD measurement set-up for 50 Ohm instrument

If the EUT neither sources nor sinks power the blocking capacitors may be omitted, as may the current sink. If present the capacitors shall be matched in value to within 1%.

If the EUT is line powered then the test circuit shall contain provisions for DC power feed, instead of the current sink.

For line powered applications, if the EUT is a TU-C the test shall be performed with the line power supply activated and an appropriate DC current sink (with high AC impedance) attached to the test circuit. If the EUT is a TU-R the test shall be performed with power (DC voltage) applied at the line interface by an external voltage source feeding through an AC blocking impedance. Note that the DC current source/sink must present high impedance (at signal frequencies) to common ground. The test circuit contains provisions for transformer isolation for the measurement instrumentation. Transformer isolation of the instrumentation input prevents measurement errors from unintentional circuit paths through the common ground of the instrumentation and the EUT power feed circuitry. When the termination impedance of the test circuit seen by the EUT output meets the calibration requirements defined in section 6.4.3, the test circuit will not introduce more than ± 0.25 dB error with respect to a perfect test load of exactly the specified resistance.

If the EUT is supplied with a voice-band splitter filter[4] then the tests shall be carried out with the splitter in circuit but with no voice-band signal applied. Where the splitter has a connector for the voice-band connection, this shall be open circuit during tests. Where voice-band equipment is integrated with the splitter this equipment shall be quiescent during tests.

The EUT shall be measured by equipment that is not synchronous with the transmitted symbols of the EUT, and there shall be no synchronization between the measurement equipment and the EUT. This is to avoid any cyclo-stationarity effects causing a misleading measurement.

6.4.3   Calibration of the test circuit and termination impedance

The nominal termination impedance of the test circuit as seen by the EUT output shall be resistive with a resistance of R between 100 Ω and 135 Ω. If the EUT has been designed to a published standard then the resistive impedance specified in that standard shall be used (providing it is between 100 Ω and 135 Ω). The minimum return loss with respect to the termination impedance R shall be 35 dB from 10 kHz to 2 MHz with a reduction of 20 dB/decade below and above these corner frequencies.

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[4] e.g. to allow DSL and ordinary telephony to share the line
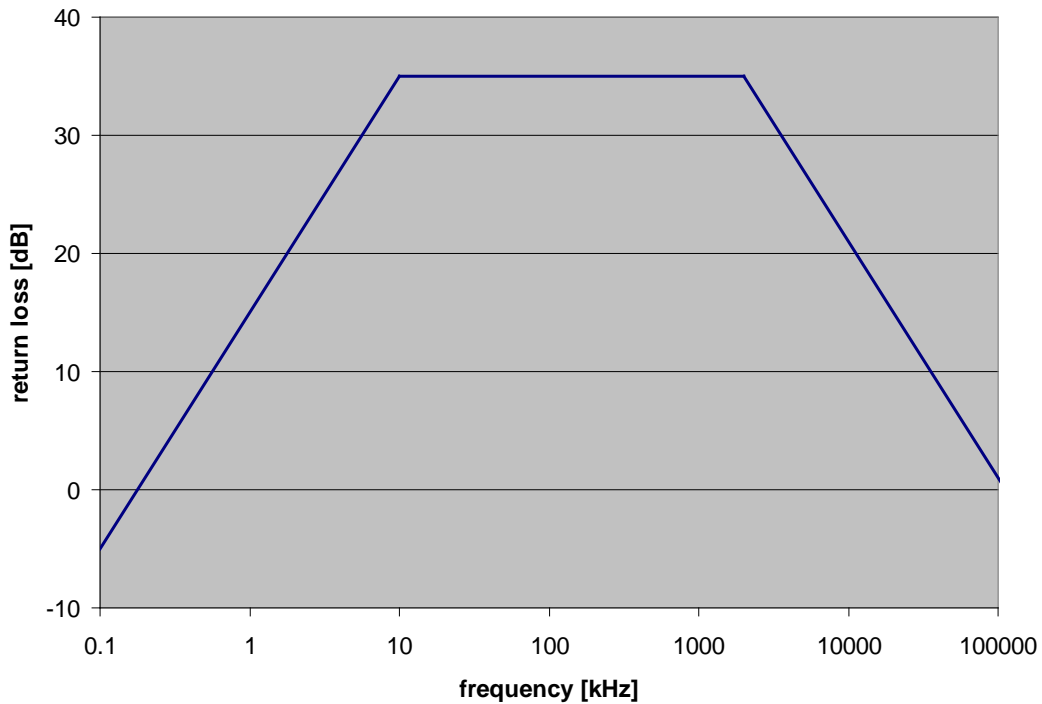
Figure 7 - Return loss mask

Figure 7 shows the return loss mask. The test circuit must exhibit this loss or higher at all frequencies.

Note 1.   No passive circuit can exhibit a negative return loss, so calibration has implied limits on the frequency band to be measured over.

Note 2.   35 dB return loss will allow ±0.20 dB measurement error with respect to the nominal termination impedance value, R.

6.4.4   Operation of the EUT

The EUT shall be tested while it transmits maximum power and maximum PSD levels at all measured frequencies, which it can transmit when deployed. The EUT shall have power cutback or boost configured to match the proposed deployment.

There are 2 methods of getting the EUT into the required configuration for testing:

- **Method 1** is for the EUT to have a special test mode that causes the EUT to transmit as it would normally in a steady state.

- **Method 2** is for the EUT to have a 'freeze' mode. This method allows the EUT to train up normally over a real or simulated loop in communications with a far end device and then places the EUT in a 'freeze' mode. In this freeze mode, the EUT continues to transmit at the same power levels even when it is not connected to the real or simulated loop and far end device.

Method 2 shall be used in the case when the PSD mask of the EUT is determined by the EUT based on its own measurement of line conditions (e.g. in the case of 3 - 5.1 MHz range of ANFP Part C). Method 1 or 2 may be used in all other cases.

The EUT shall be tested under steady state conditions, after all start-up and initialization procedures have been completed and while the EUT is transmitting data. To ensure that the EUT is in a steady-state condition, while undergoing test the EUT shall not have measured total average powers in distinct 1.25 millisecond time intervals that differ by more than 8 dB. The EUT input shall consist of a pseudo-

random uniformly distributed data sequence, and the EUT output shall be a fully modulated transmit signal with all overhead, framing, coding, scrambling, modulation, filtering and all other operations performed on the data stream that the modem would normally perform while transmitting data.

Note.   Although specific measurements of average power and PSD during start-up and other non-data transmission phases are not provided, a EUT that transmits inordinately high power or PSD levels during these phases that causes network harm may be considered to be in non-compliance with this standard.

6.4.5   Power spectral density (PSD) measurement procedure

6.4.5.1   PSD resolution bandwidth

The nominal frequency of a measurement will be the centre frequency of its resolution bandwidth. Instrument Resolution Bandwidth (RBW) shall be 10 kHz. Measurements will be at integer multiples of 10 kHz, starting at 10 kHz, so the lowest frequency measurement will be nominally 10 kHz and actually a window from 5 kHz to 15 kHz.

Inside the signal bands defined in tables the measured values for each 10 kHz band shall be compared against the masks individually. Outside the signal bands the measured values will be averaged in overlapping groups of one hundred 10 kHz bands, to produce the effect of a 1 MHz RBW sliding window; the averaged values will be compared against the masks.

The mask value to be compared against shall be the maximum value the mask takes within the effective window. (Typically the first few steps of the 1 MHz sliding window will be compared against substantially higher values than the mask at the nominal centre frequency would suggest).

For the ANFP masks this means the bandwidth resolutions used will be depend on which PSD mask the EUT is being tested for compliance. The required bandwidth resolution is defined in the relevant Part (i.e. Part A, B, C or D) of this document.

6.4.5.2   PSD Integration Time

Measurements shall be averaged over a sufficiently long time that the contribution to measurement uncertainty shall be no worse than 0.1 dB with 95% confidence. (For some spectrum analysers this will imply limits on video bandwidth and sweep time).

6.5   Non-stationary Signals

This sub-section is informative and not normative. It concerns equipment that only transmits power intermittently – typically when there is data to send. The significant impact of such signals is due to their power when transmitting, not an average over all time.

It is technically difficult to specify how to measure intermittent signals, unless the equipment has a continuous signal test mode (in which case it may be sufficient to conduct tests in that mode, as for normal equipment). Furthermore, at time of writing there is little practical interest in deploying such equipment under the ANFP. Therefore a normative laboratory test specification is not provided.

Note: The ATIS Spectrum Management specification [14] does specify some tests for such signals, in its section 6.5 "Short-term stationary conformance criteria".

7   ANFP User Guide and Background Information

The ANFP for the KCH access network has been developed taking, as far as possible, a technology neutral approach. The criteria and method used to construct the ANFP conforms to the methodology used in the KCH ANFP NICC ND 1604:2006/09 Issue 2 6], Annex 4.

The ANFP defines the maximum signal power levels that may be transmitted into the KCH access network at the various points of connection with the objective of managing the crosstalk interference. It does *not* directly define what xDSL systems may be connected to the KCH access network or what bandwidth services may be deployed. Guidance on what ANFP-compliant xDSL systems may be connected to the KCH access network is given in the Part E of this document. However, it should be noted that it is the responsibility of the owner of the xDSL system connected to the KCH access network to ensure that the equipment is, and remains, ANFP compliant. It is this ANFP specification that is the authoritative document. Part E has only informative status.

8   ANFP Change Control Procedure

The following ANFP Change Control Procedure is agreed and adopted by the NICC DSL Working Group.

Recognising that:

   a)   the implementation of the ANFP limits the type of telecommunications system that can be connected to the KCH Access Network and the location of that connection.

   b)   the implementation of the ANFP limits the crosstalk experienced by systems connected to the KCH Access Network.

   c)   the business plans of network operators, service providers and customers may be affected by changes to the ANFP. Hence the stability of the ANFP (i.e. minimum period that could exist before the ANFP could be changed to the detriment of an organisations or individuals plans) needs to be defined in order that commercial risks can be assessed and investment decisions taken.

   d)   multiple amendments to the ANFP will have a cumulative impact on existing systems, perhaps leading to significant degradation of service even if no individual amendment is significant.

   e)   experience gained from the operation of the KCH and other Access Networks in a multi-operator environment may provide improved understanding of the complex crosstalk interaction between telecommunication systems operating on different metallic pairs within an Access Network. This improved understanding may result in the need to amend this ANFP.

The NICC DSL Working Group adopt the following change control procedure for the ANFP:

   1.   A proposal to amend the ANFP may be submitted as an NICC work item at any time by any member of the NICC. The proposed work item shall be submitted to the NICC Board and will be subject to NICC Standards Limited Articles of Association [24] specifically the work programme section.

   2.   Any proposal to amend the ANFP should contain: -

        •   an impact assessment statement on at least the telecommunication systems listed in Part E.

        •   a proposed date for implementation.

   3.   The NICC DSL Working Group will adopt a proposed ANFP amendment if there is consensus agreement i.e. there is no sustained objection from any member of the Working Group. The Working Group will take into account:

- the impact of the proposed amendment on the current issue of the ANFP

- the desire that any future changes should not have a worse effect on existing deployed DSL technologies, than the DSL technologies on themselves.

- the need to discourage changes that would be likely to further erode the cross-talk noise environment, and might lead to denial of service, loss of service, or reduction in service quality for existing services. In the case of a proposal for such a relaxation, it is recommended that full consideration be given to the public interest benefit of such a change.

- the need to encourage changes that would improve the overall crosstalk noise environment in the long term, with the objective of increasing the ubiquity of broadband services.

4. Any objection to a proposed amendment should be supported by technical data to support the reasons for the objection.

5. Where there is no consensus agreement, the proposed amendment shall be passed to the NICC Board for determination and will be subject to NICC Standards Limited Articles of Association [24] specifically the "Approval of NICC Documents" section.

Part A (normative):
ANFP PSD Mask Definition for MDF

A.1   Introduction

This part of the ANFP specifies the PSD Mask that applies to transmission equipment connected to the MDF at an MDF site when that MDF is connected to cables routed to the NTP via a SLCP. This part also applies in the case where the MDF is connected to cables routed directly to the NTP (i.e. with no SLCP in the routing) and where those cables are in the same cable sheath as metallic access cables routed via a SLCP.

Note: Part D applies in the case where the MDF is connected to cables routed directly to the NTP (i.e. with no SLCP in the routing) and where those cables are *not* in a cable sheath with any metallic access cables routed via a SLCP.

A.2   PSD Mask Specification

The (downstream) MDF PSD Mask is as shown in
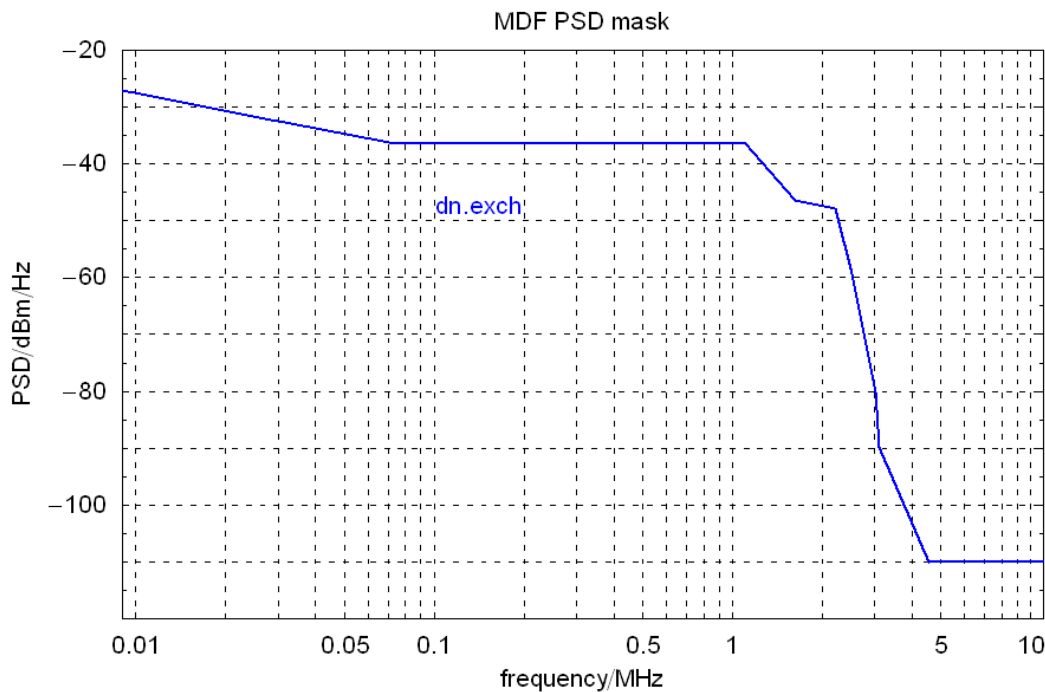
Figure A.1 and is specified in Table A.1
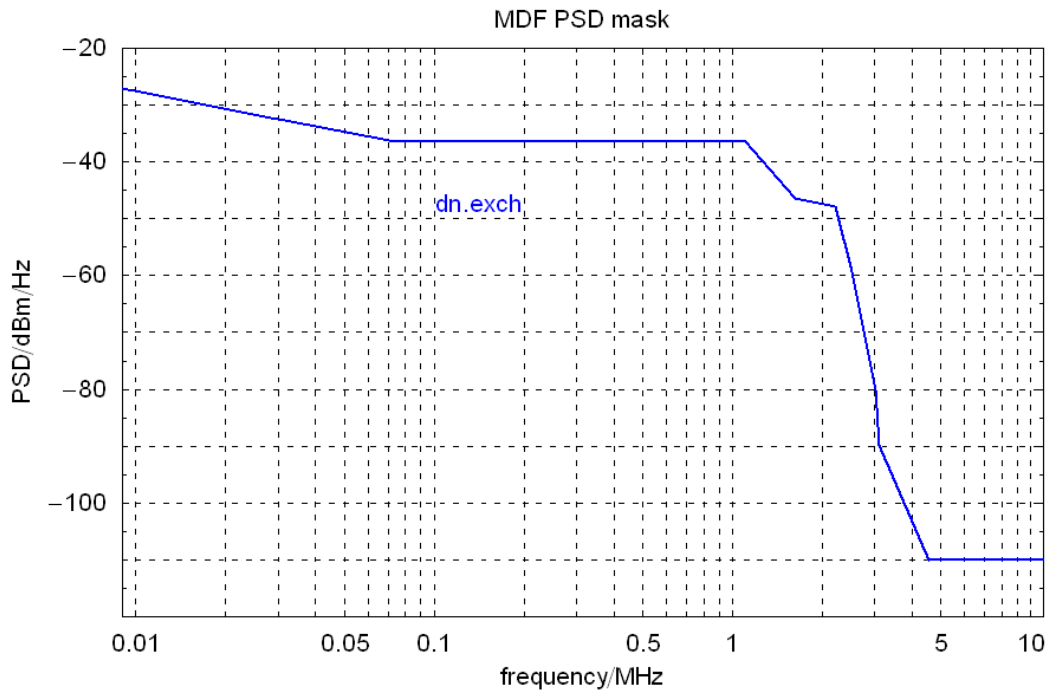
Figure A.1 - MDF PSD Mask

The mask is defined in the data given in Table A.1. The tabulated data defines the corners of the mask. Between the given corners, the mask values are defined by interpolation (as a straight line on log frequency/linear dB axes).

Frequency MHz	MDF Down dBm/Hz
0.0001	-24.24
0.0004	-24.26
0.001	-24.31
0.002	-24.44
0.003	-24.64
0.004	-24.9
0.00401	-24.9
0.005	-25.23
0.006	-25.63
0.006058	-25.66
0.007177	-26.23
0.029769	-32.48
0.03	-32.5

0.074273	-36.5
1.104	-36.5
1.622	-46.5
2.208	-47.8
2.5	-59.4
3.0015	-80
3.0861	-86.893
4.545	-110
30	-110

Table A.1 - MDF PSD Mask specification

Note: The data given in Table A.1 is available in electronic format [21]. In the event of any discrepancy between the data given in the spreadsheet [21] and that in Table A.1, the data in Table A.1 applies.

A.3   Test Specification

The test specification specified in section 6 applies using the resolution bandwidths specified in Table A.2

Frequency Band	Resolution Bandwidth
100 Hz to 5 kHz	100 Hz
5 kHz to 3095 kHz	10 kHz
3095 kHz to 30005 kHz	1 MHz

Table A.2 - Resolution Bandwidth for measuring against MDF PSD Mask

- End of Part A -

Part B (normative):
ANFP PSD Mask Definition for SDF

B.1   Introduction

This part of the ANFP specifies the PSD Mask that applies to transmission equipment connected to the SDF at an SLCP site.

B.2   Cabinet Assigned Loss

The ANFP defines a range of PSD masks for the cabinet SDF depending on the loss from the MDF site to the SDF site. As there may be more than one type and route of cable between these two sites with disparate losses the nominal loss for a given cabinet may be based on the statistics of these losses, with the resulting loss figure being called the Cabinet Assigned Loss (CAL).

A Cabinet Assigned Loss will be identified for all KCH cabinets based on estimates of the losses of all the cables between the MDF site and the SDF site. New KCH cabinets will be given a Cabinet Assigned Loss upon completion of their installation. Once the assignment has been made, it is fixed and will only change if that cabinet (or the cables terminating on the cabinet) are subject to a significant engineering modification (e.g. re-routing due to a road development scheme) or to an ANFP assignment check process that results in a change in the assignment.

The Cabinet Assigned Loss is in terms of 'electrical distance' from the MDF, defined by loss values at 300kHz - this is the parameter CAL in Table B1. The actual value of the Cabinet Assigned Loss can be plugged into table B.1 as the value of CAL in order to derive the mask applicable to that cabinet. Masks as appearing in Figure B.1 will result from evaluating the table with the given values of CAL.

B.3   PSD Mask Specification

Some of the possible (downstream) SDF PSD masks are shown in Figure B.1. Table B.1 can be used to obtain a mask for any Cabinet Assigned Loss by evaluating its contents substituting CAL with the given Cabinet Assigned Loss.
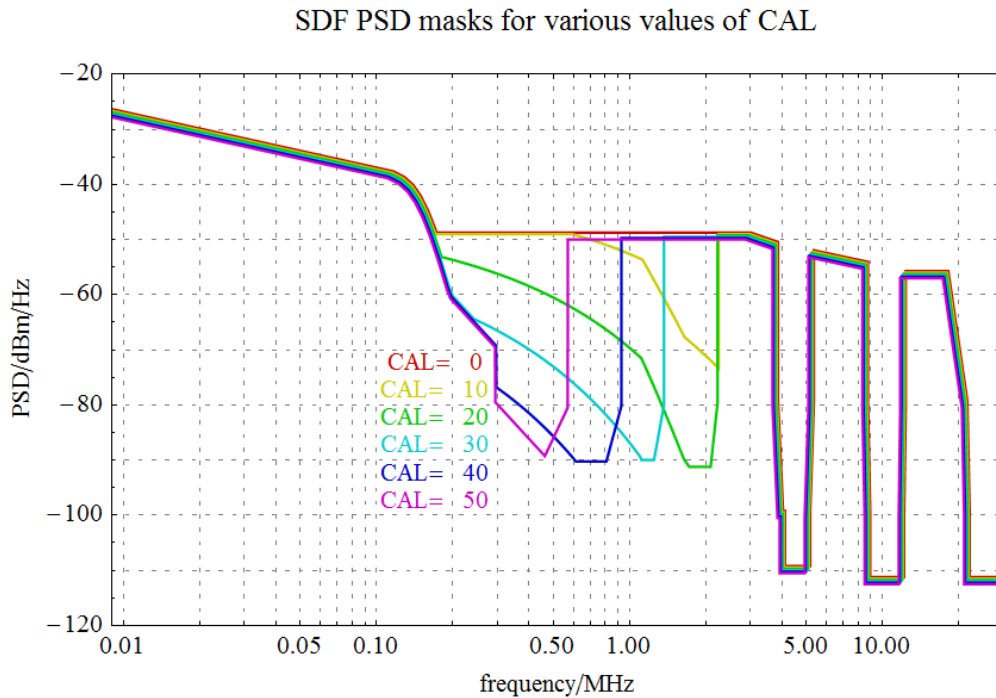
Figure B.1 - SDF PSD masks for various values of CAL

(note: the lines plotted in this graph have been nudged from their true positions to help
clarify their tracks as without doing this many lines would lie on top of each other)

The masks are defined by the data given in Table B.1. The tabulated data in the right-most column defines the corners of the mask. Between the given corners, the mask values are defined by interpolation (as a straight line on log frequency/linear dB axes).

In order to get appropriate values for the right-most column, the intermediate columns must first be calculated:

The second column, headed "LF_part" describes low frequency signals that are permitted without power control at the SDF.

The third column, headed "from_MDF" describes signals that are permitted downstream at the exchange and corresponds with the mask of Table A.1.

The fourth column, headed "attenuation" is a simplified function fit designed to model the loss of E-side cables. It does this on the basis of a single parameter, CAL, and it is this column that is influenced by this parameter. Subtracting "attenuation" of column 4 from "from_MDF" of column 3 therefore generates an estimate of the maximum strength of a signal from the MDF as it passes the cabinet.

The fifth column, "boost" describes a high-pass PSD, enabling frequencies above fmax to be transmitted unattenuated. fmax is calculated as shown in the header row of the table by solving the equation from_MDF(f)-attenuation(f)=-101.5 for f. The value of fmax is then constrained to the range 0.552 to 2.208 MHz to eliminate unusable solutions. The actual "boost" PSD is then obtained by interpolating the five co-ordinates in column 5, given fmax, on the usual straight line on log frequency/linear dB axes.

Finally the SDF PSD of the right-most column is derived by choosing among the PSDs from the previously calculated columns in the algorithmic way defined. In words this consists of choosing either from_MDF-attenuation or boost or –91.5 whichever is largest, then choosing either this result or -49.5, whichever is smallest, then choosing either this result or LF_part, whichever is largest.

The reason for the very long list of frequencies in column one is that the entered values ensure the functions are calculated at all the critical intersection points of the columns for a wide range of values of CAL (0 to 52 dB in steps of 2 dB).

fmax= $\max(0.552;\min(2.208;{}^{5}\text{solve(from\_MDF}(f)-\text{attenuation}(f)=-101.5)))$

f MHz	LF_part dBm/Hz	from_MDF dBm/Hz	attenuation dB	boost dBm/Hz	SDF PSD dBm/Hz
0.000100					-24.25
0.004010					-24.94
0.006058					-25.66
0.007177					-26.23
0.029549					-32.46
0.030000			[6]X		-32.50
0.030286					-32.57
0.113066					-38.38
0.125211					-39.41
0.135572					-40.85
0.145222					-42.82
0.155286					-45.51
0.166091	-48.92	-36.50	X	X	-48.92
0.167711	a	[7]a			
0.168514	a	a			
0.173677	a	a			
0.179000	-53.37	a			
0.179093	a	a			
0.184151	a	a			
0.189451	a	a			
0.193000	a	a			
0.193467	-58.52	a			
0.194000	a	a			
0.195528	a	a	CAL * (0.4218 + 0.8136 * √f + 0.4417 * f)	[8]interpolate((0.167711;-95); (fmax-0.175;-95); (fmax-0.001;-80); (fmax;-49.5); (2.208;-49.5))	[9]max(LF_part; [10]min(-49.5; max(-91.5; boost; from_MDF-attenuation)))
0.199000	a	a			
0.199724	-60.16	a			
0.200000	a	a			
0.211479	a	a			
0.226000	a	a			
0.241718	a	a			
0.242706	a	a			
0.264000	a	a			
0.286050	a	a			
0.300000	-69.00	a			
0.300150	a	a			
0.300351	a	a			
0.300552	a	a			
0.300753	a	a			

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[5] fmax is found by solving this equation for f, but restricting the solution to the range 0.552 – 2.208 MHz.

[6] "X" means the values in these parts of the table are irrelevant as they do not influence the value of the right-most column.

[7] The symbol "a" means that the value for this frequency can be obtained by linear interpolation on a log frequency scale of the values given in the nearest preceding and following rows that actually contain a numerical value.

[8] this component of the PSD depends on fmax, extending down from 2.208 MHz to 0.552 MHz as CAL increases.

[9] The function max(x;y;..) means x or y, whichever is closest to +∞

[10] The function min(x;y) means x or y, whichever is closest to -∞

fmax= $\max(0.552; \min(2.208; \sqrt[5]{\text{solve(from\_MDF(f)-attenuation(f)}=-101.5)}))$

f MHz	LF_part dBm/Hz	from_MDF dBm/Hz	attenuation dB	boost dBm/Hz	SDF PSD dBm/Hz
0.300954	a	A			
0.301000	-79.00	A			
0.318000	a	A			
0.336000	a	a			
0.354000	a	a			
0.372895	a	a			
0.392000	a	a			
0.411000	a	a			
0.431000	a	a			
0.452118	a	a			
0.472343	a	a			
0.500000	-90.00	a			
0.515697	a	a			
0.551000	a	a			
0.552000	a	a			
0.555757	a	a			
0.579027	a	a			
0.581455	a	a			
0.582455	a	a			
0.621270	a	a			
0.637736	a	a			
0.638736	a	a			
0.649711	a	a	CAL * (0.4218 + 0.8136 * √f + 0.4417 * f)	interpolate((0.167711;-95); (fmax-0.175;-95); (fmax-0.001;-80); (fmax;-49.5); (2.208;-49.5))	max(LF_part; min(-49.5; max(-91.5; boost; from_MDF-attenuation)))
0.673000	a	a			
0.695906	a	a			
0.700452	a	a			
0.701452	a	a			
0.728936	a	a			
0.770583	a	a			
0.771583	a	a			
0.781367	a	a			
0.818138	a	a			
0.849308	a	a			
0.850308	a	a			
0.879782	a	a			
0.919072	a	a			
0.938057	a	a			
0.939057	a	a			
0.993847	a	a			
1.011825	a	a			
1.038579	a	a			
1.039579	a	a			
1.083405	a	a	CAL * (0.4218 + 0.8136 * √f + 0.4417 * f)	interpolate((0.167711;-95); (fmax-0.175;-95); (fmax-0.001;-80); (fmax;-49.5); (2.208;-49.5))	max(LF_part; min(-49.5; max(-91.5; boost; from_MDF-attenuation)))
1.104000	a	-36.50			
1.115835	a	a			
1.131023	a	a			
1.132023	a	a			
1.162598	a	a			
1.191514	a	a			
1.193843	a	a			
1.202399	a	a			
1.203399	a	a			
1.250679	a	a			
1.281361	a	a			
1.281396	a	a			
1.282396	a	a			

fmax= $\max(0.552; \min(2.208;\ ^{5}\text{solve}(\text{from\_MDF}(f) - \text{attenuation}(f) = -101.5)))$

f MHz	LF_part dBm/Hz	from_MDF dBm/Hz	attenuation dB	boost dBm/Hz	SDF PSD dBm/Hz
1.346324	a	A			
1.349225	a	A			
1.369286	a	A			
1.370286	a	A			
1.380244	a	A			
1.400000	-90.00	a			
1.448180	a	a			
1.467647	a	a			
1.468647	a	a			
1.536799	a	a			
1.546807	a	a			
1.578462	a	a			
1.579462	a	a			
1.622000	a	-46.50			
1.622545	a	a			
1.707533	a	a			
1.757552	a	a			
1.758552	a	a			
1.869121	a	a			
1.931000	a	a			
1.994263	a	a			
2.003923	a	a			
2.004923	a	a			
2.072331	a	a			
2.110313	a	a			
2.162299	a	a			
2.207000	a	a	CAL * (0.4218 + 0.8136 * √f + 0.4417 * f)	interpolate((0.167711;-95); (fmax-0.175;-95); (fmax-0.001;-80); (fmax;-49.5); (2.208;-49.5))	max(LF_part; min(-49.5; max(-91.5; boost; from_MDF-attenuation)))
2.207031	a	a			
2.207202	a	a			
2.207372	a	a			
2.207543	a	a			
2.207714	a	a			
2.207885	a	a			
2.208000	-104.32	-47.80	X	X	-49.50
2.209000					-49.50
2.93081					-49.5
3.75					-51.2
3.751					-80
3.925					-100
4					-100
4.001					-110
5.024					-110
5.025			X		-100
5.199					-80
5.2					-52.7
8.5					-54.8
8.501					-80
8.675					-100
8.676					-112
11.824					-112
11.825					-100
11.999					-80

fmax= $\quad$ max(0.552;min(2.208;$^{\mathbf{5}}$solve(from_MDF(f)-attenuation(f)=-101.5)))

f MHz	LF_part dBm/Hz	from_MDF dBm/Hz	attenuation dB	boost dBm/Hz	SDF PSD dBm/Hz
12					-56.5
17.664					-56.5
21					-80
21.45					-100
21.451					-112
30					-112

Table B.1 - SDF PSD mask defined in terms of CAL

Note: The data given in Table B.1 is available in electronic format [21]. In the event of any discrepancy between the data given in the spreadsheet [21] and that in Table B.1, the data in Table B.1 applies.

B.4   Test Specification

The test specification specified in section 6 applies using the resolution bandwidths specified in Table B.2.

Frequency Band	Resolution Bandwidth
100 Hz to 5 kHz	100 Hz
5 kHz to 3755 kHz	10 kHz
3755 kHz to 5195 kHz	1 MHz
5195 to 8505 kHz	10 kHz
8505 to 11995 kHz	1 MHz
11995 to 21005 kHz	10 kHz
21005 to 30005 kHz	1MHz

Table B.2 - Resolution Bandwidth for measuring against SDF PSD Mask

- End of Part B -

Part C (normative):
ANFP PSD Mask Definition for NTP

C.1   Introduction

This part of the ANFP specifies the PSD Mask that applies to equipment connected to the NTP at customers' premises.

C.2   Line Categorisation

This part of the ANFP defines different NTP PSD masks for the customer end depending on distance from the MDF site - primarily the physical line length but also taking account the categorisation of other lines terminating at the same DP (Distribution Point). The definition of Short, Medium and Long continues to be based on the accommodation of SHDSL [28] technology operating at different line rates.

This classification into Short, Medium and Long is applied to all existing KCH line ends based on an estimate of the physical length of a line to the exchange. New KCH lines will be classified upon completion of their installation. Once the classification has been undertaken, the classification for a given end is fixed and will only change if that line (or the lines terminating on the same DP) is subject to a significant engineering modification (e.g. re-routing due to a road development scheme) or to an ANFP category check process that results in a change in the category.

Like all other lines, the classification allocated to private circuits would be fixed and would only change if the lines forming that private circuit were subject to significant engineering modification.

The categorization of customers' locations is in terms of 'electrical distance' from the MDF, defined by loss values at 100 kHz, for a nominal line to the MDF. The categories are defined in Table C.1 and illustrated in Figure C.2.

Category name	is applied to interfaces at these locations
(Up) Short	the customer NTP where nominal distance from the MDF is 0.74Km or less
(Up) Medium	the customer NTP where the nominal distance from the MDF is between 0.74 km and 1.68 km
(Up) Long	the customer NTP where the nominal distance from the MDF is over 1.68 km

Table C.1 – ANFP Interface Category Definitions

Note that despite the names it is the interfaces that are categorized, and that neighbouring line interfaces have the same limits irrespective of the electrical properties of their respective pairs[11]. Hence in general all interfaces sharing a given DP[12] will be categorized the same.

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[11] because spectrum management is about limiting harm to neighbours, not directly about what a given line is capable of

[12] Distribution Point – the final flexibility point in the KCH access network before the line reaches its customer.
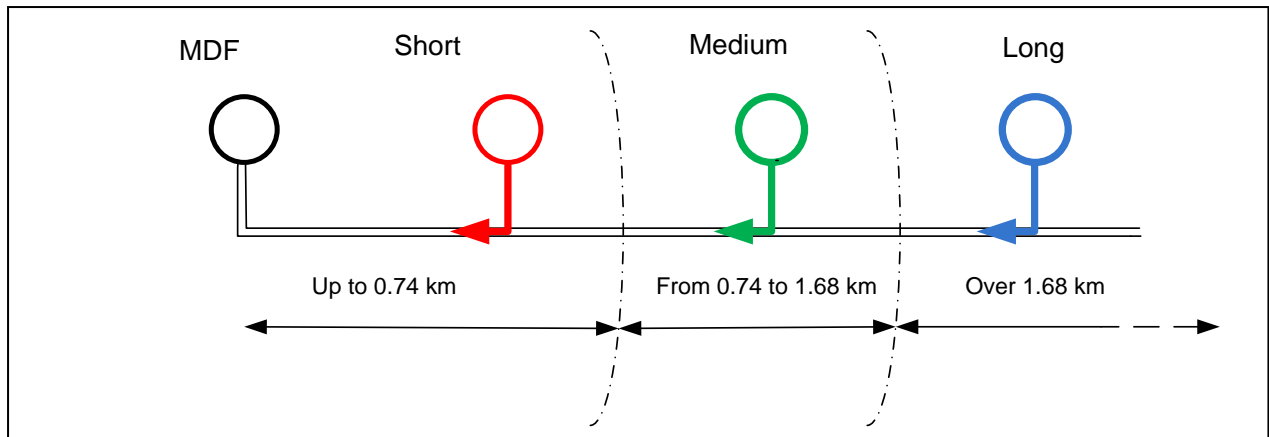
Figure C.1 – The ANFP Interface Categories

In addition each of the masks incorporates power-controlled bands between 3.74 and 5.25 MHz and between 8.40 and 12.10 MHz in which the transmit mask is dependent on the estimated distance (in terms of electrical length) of the NTP from the SDF at the cabinet. It is the responsibility of the operator of equipment at the SDF to estimate this electrical length and impose appropriate controls on the equipment at the customers' premises. Equipment that is not aware of its distance from the SDF must assume that this distance is zero and comply with the version of the mask for its ANFP category that results from this assumption.

Note: The Broadband Forum produces the guidelines for interoperability performance of DSL transceivers. For VDSL2, the relevant test plans are [22].
The Broadband Forum also works with a number of Independent Test Laboratories (ITLs, see http://www.broadband-forum.org/technical/independenttestlaboratories.php) who are expert at undertaking interoperability and performance assessments of various vendors' DSL equipment in accordance with DSL Forum published test plans. Service providers can make use of such results to determine the service deployment rules that meet their business requirements.

C.3   PSD Mask Specification

In any distribution area (from SLCP), an operator may conform to the ANFP in either of the following two ways:

1.   Using a static mask as defined in section C.3.1.

2.   Using dynamic configuration as defined in section C.3.2.

C.3.1   Static PSD Mask Specification

Some of the possible (upstream) NTP PSD Masks for each line category are shown in Figure C.2 for a range of possible values of kl0. The masks are defined in terms of an arbitrary value of kl0 in Table C.2.
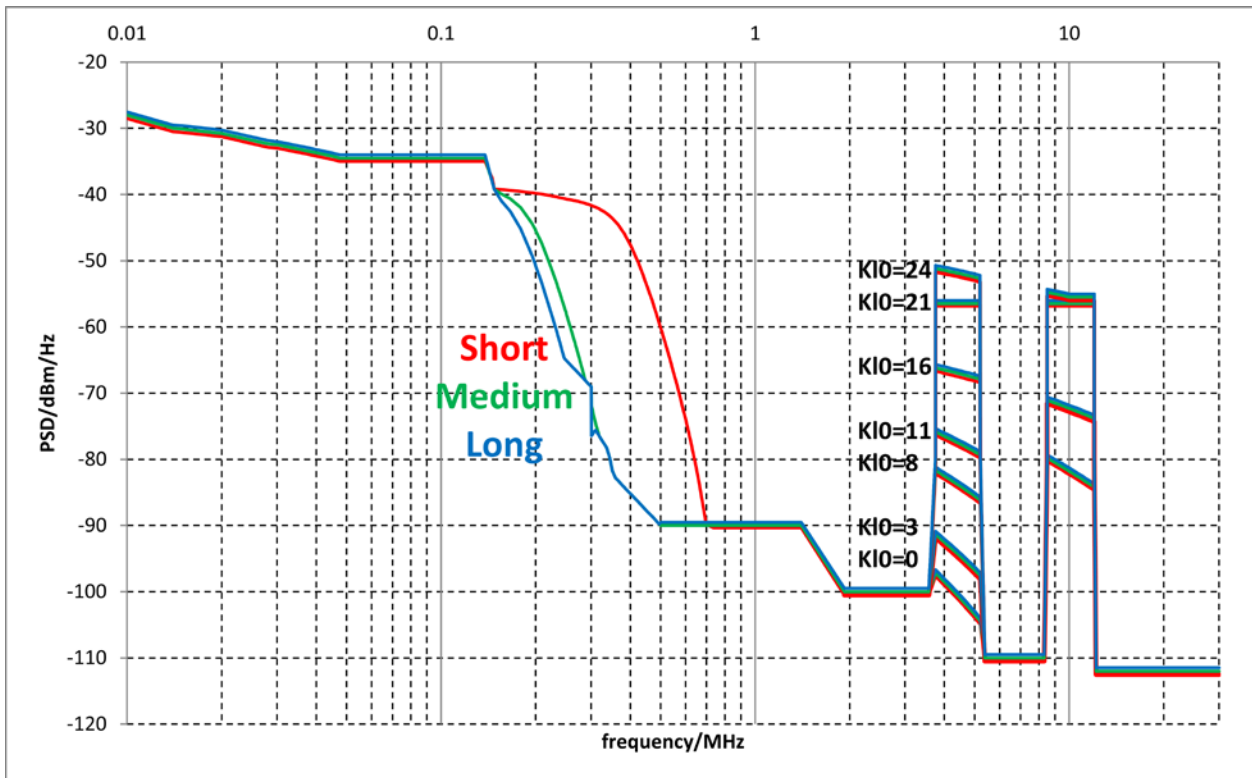
**Figure C.2 – Short, Medium and
Long PSD masks for various values of kl0**

(note: the lines plotted in this graph have been nudged from their true positions to help
clarify their tracks as without doing this many lines would lie on top of each other)

The data of Table C.2 defines the corners of the masks. The parameters in Table C.2 shall be set at A1=60, B1=21, A2=60, and B2=8. Between the given corners, the mask values are defined by interpolation (as a straight line on log frequency/linear dB axis).

The mask in the frequency ranges between 3.74 and 5.25 MHz and between 8.40 and 12.10 MHz depends on the electrical length kl0 of the cable between the SDF and the NTP. kl0 is the electrical length of the loop over which signals are transmitted in these bands. It can be estimated as min(loss(f)/√f), where loss(f) is the loss of the loop at frequency f. loss(f) is expressed in dB and f is expressed in MHz. It can either be estimated by the transmission equipment during operation, or by the operator at install time. If it is desired to install without knowledge of kl0 of the loop then the mask for kl0=0 must be complied with.

Frequency MHz	Up Short NTE dBm/Hz	Up Medium NTE dBm/Hz	Up Long NTE dBm/Hz
0.0001	-24.24	-24.24	-24.24
0.0004	-24.26	-24.26	-24.26
0.001	-24.31	-24.31	-24.31
0.002	-24.44	-24.44	-24.44
0.003	-24.64	-24.64	-24.64
0.004	-24.9	-24.9	-24.9
0.00401	-24.9	-24.9	-24.9
0.005	-25.23	-25.23	-25.23
0.006	-25.63	-25.63	-25.63
0.006058	-25.66	-25.66	-25.66
0.007	-26.13	-26.13	-26.13
0.007177	-26.23	-26.23	-26.23
0.009	-27.3	-27.3	-27.3
0.01	-28	-28	-28
0.014	-30	-30	-30
0.015	-30.1	-30.1	-30.1
0.02	-30.76	-30.76	-30.76
0.025875	-31.97	-31.97	-31.97
0.028	-32.33	-32.33	-32.33
0.029769	-32.48	-32.48	-32.48
0.03	-32.5	-32.5	-32.5
0.037	-33.35	-33.35	-33.35
0.045	-34.2	-34.2	-34.2
0.047884	-34.5	-34.5	-34.5
0.048147	**13**A	a	a
0.048187	A	a	a
0.06	A	a	a
0.06666	A	a	a
0.074273	A	a	a
0.075	A	a	a
0.1001	A	a	a
0.138	-34.5	-34.5	-34.5
0.145222	-38.04	-38.04	-38.04
0.147654	-39.15	-39.19	-39.19
0.155286	-39.23	-39.89	-40.93
0.166091	-39.36	-40.63	-42.53
0.179	-39.51	-41.96	-45.17
0.193467	-39.71	-44.18	-48.9
0.194696	-39.72	-44.4	-49.25
0.199722	-39.8	-45.38	-50.67
0.2	-39.8	-45.44	-50.75
0.208333	-39.92	-47.24	-53.19
0.21561	-40.04	-48.96	-55.36
0.222373	-40.15	-50.64	-57.4
0.23345	-40.35	-53.51	-60.77
0.235084	-40.38	-53.94	-61.26

Frequency MHz	Up Short NTE dBm/Hz	Up Medium NTE dBm/Hz	Up Long NTE dBm/Hz
0.239	-40.46	-54.98	-62.46
0.246148	-40.6	-56.89	-64.65
0.248	-40.63	-57.39	-64.86
0.249819	-40.66	-57.87	-65.02
0.250067	-40.66	-57.94	-65.04
0.256	-40.75	-59.54	-65.55
0.25627	-40.76	-59.61	-65.58
0.262988	-40.87	-61.43	-66.14
0.263	-40.87	-61.44	-66.14
0.265315	-40.9	-62.06	-66.33
0.266667	-40.93	-62.43	-66.44
0.267397	-40.94	-62.63	-66.5
0.268	-40.95	-62.79	-66.55
0.271	-41	-63.61	-66.79
0.272638	-41.03	-64.06	-66.92
0.273	-41.04	-64.16	-66.95
0.278421	-41.14	-65.64	-67.38
0.281	-41.19	-66.35	-67.58
0.283116	-41.24	-66.93	-67.74
0.286003	-41.3	-67.73	-67.96
0.287008	-41.32	-68.01	-68.04
0.291333	-41.41	-68.36	-68.36
0.292485	-41.44	-68.45	-68.45
0.295483	-41.51	-68.67	-68.67
0.299161	-41.6	-68.94	-68.94
0.3	-41.62	-69	-69
0.301	-41.65	-71.94	-76.44
0.303	-41.7	-72.52	-76.24
0.303982	-41.73	-72.8	-76.14
0.307	-41.81	-73.67	-75.85
0.308232	-41.84	-74.03	-75.73
0.310322	-41.9	-74.64	-75.59
0.318586	-42.16	-76.46	-76.46
0.319	-42.18	-76.5	-76.5
0.327566	-42.49	-77.37	-77.37
0.333	-42.71	-77.92	-77.92
0.333143	-42.72	-77.93	-77.93
0.333333	-42.72	-77.95	-77.95
0.3367	-42.87	-78.28	-78.28
0.344065	-43.23	-79.78	-79.78
0.34445	-43.25	-79.89	-79.89
0.349963	-43.54	-81.46	-81.46
0.351	-43.6	-81.75	-81.75
0.358742	-44.08	-82.8	-82.8
0.366157	-44.58	-83.25	-83.25
0.378	-45.51	-83.94	-83.94

Cont

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13 The Symbol "a" means that the value for this frequency can be obtained by linear interpolationon a log frequency scale of the values givin in the nearest preceeding and teh following rows that actually contains a numerical value.

Frequency MHz	Up Short NTE dBm/Hz	Up Medium NTE dBm/Hz	Up Long NTE dBm/Hz
0.38	-45.68	-84.05	-84.05
0.382919	-45.93	-84.22	-84.22
0.384295	-46.05	-84.3	-84.3
0.399	-47.47	-85.11	-85.11
0.4	-47.57	-85.16	-85.16
0.404253	-48.02	-85.39	-85.39
0.404794	-48.07	-85.42	-85.42
0.404807	-48.08	-85.42	-85.42
0.423859	-50.24	-86.42	-86.42
0.427391	-50.67	-86.6	-86.6
0.433333	-51.39	-86.9	-86.9
0.441289	-52.39	-87.29	-87.29
0.452464	-53.82	-87.83	-87.83
0.456865	-54.4	-88.04	-88.04
0.469474	-56.06	-88.63	-88.63
0.479432	-57.38	-89.09	-89.09
0.482646	-57.81	-89.23	-89.23
0.487516	-58.47	-89.45	-89.45
0.492	-59.07	-89.65	-89.65
0.494218	-59.37	-89.75	-89.75
0.5	-60.15	-90	-90
0.501667	-60.37	a	a
0.50365	-60.64	a	a
0.508812	-61.34	a	a
0.515146	-62.2	a	a
0.520871	-62.98	a	a
0.523446	-63.33	a	a
0.534365	-64.82	a	a
0.545545	-66.35	a	a
0.548595	-66.76	a	a
0.564058	-68.89	a	a
0.57	-69.72	a	a
0.579787	-71.08	a	a
0.582667	-71.49	a	a
0.6	-73.95	a	a
0.602626	-74.32	a	a
0.613094	-75.84	A	a
0.625055	-77.61	A	a
0.630511	-78.43	A	a
0.65	-81.45	A	a
0.661743	-83.36	A	a
0.697042	-89.77	A	a
0.735	-90	A	a
1.104	a	A	a
1.4	-90	-90	-90

Frequency MHz	Up Short NTE dBm/Hz	Up Medium NTE dBm/Hz	Up Long NTE dBm/Hz
1.489432	-91.95	-91.95	-91.95
1.499983	-92.17	-92.17	-92.17
1.622	a	a	a
1.63	-94.78	-94.78	-94.78
1.924567	-100		
3.575	-100		
3.749	=min(-80,3.5-A1-1.9362 (B1-max(0,kl0)))		
3.75	=min(-51.20,3.5-A1-1.9365 (B1-max(0,kl0)))		
3.8	=min(-51.25,3.5-A1-1.9494 (B1-max(0,kl0)))		
3.9	=min(-51.36,3.5-A1-1.9748 (B1-max(0,kl0)))		
4	=min(-51.46,3.5-A1-2.0000 (B1-max(0,kl0)))		
4.1	=min(-51.56,3.5-A1-2.0248 (B1-max(0,kl0)))		
4.2	=min(-51.67,3.5-A1-2.0494 (B1-max(0,kl0)))		
4.3	=min(-51.77,3.5-A1-2.0736 (B1-max(0,kl0)))		
4.4	=min(-51.87,3.5-A1-2.0976 (B1-max(0,kl0)))		
4.5	=min(-51.98,3.5-A1-2.1213 (B1-max(0,kl0)))		
4.6	=min(-52.08,3.5-A1-2.1448 (B1-max(0,kl0)))		
4.7	=min(-52.18,3.5-A1-2.1679 (B1-max(0,kl0)))		
4.8	=min(-52.29,3.5-A1-2.1909 (B1-max(0,kl0)))		
4.9	=min(-52.39,3.5-A1-2.2136 (B1-max(0,kl0)))		
5	=min(-52.49,3.5-A1-2.2361 (B1-max(0,kl0)))		
5.1	=min(-52.60,3.5-A1-2.2583 (B1-max(0,kl0)))		
5.2	=min(-52.70,3.5-A1-2.2804 (B1-max(0,kl0)))		
5.201	=min(-80, 3.5-A1-2.2806 (B1-max(0,kl0)))		
5.375	-110		
8.325	-110		
8.499	=[14]min(-80,3.5-A2-2.9153 (B2-[15]max(0,kl0)))		
8.5	=min(-54.80,3.5-A2-2.9155 (B2-max(0,kl0)))		
8.75	=min(-54.92,3.5-A2-2.958 (B2-max(0,kl0)))		
9	=min(-55.03,3.5-A2-3.0000 (B2-max(0,kl0)))		
9.25	=min(-55.15,3.5-A2-3.0414 (B2-max(0,kl0)))		
9.5	=min(-55.27,3.5-A2-3.0822 (B2-max(0,kl0)))		
9.75	=min(-55.38,3.5-A2-3.1225 (B2-max(0,kl0)))		
10	=min(-55.50,3.5-A2-3.1623 (B2-max(0,kl0)))		
10.25	=min(-55.50,3.5-A2-3.2016 (B2-max(0,kl0)))		
10.5	=min(-55.50,3.5-A2-3.2404 (B2-max(0,kl0)))		
10.75	=min(-55.50,3.5-A2-3.2787 (B2-max(0,kl0)))		
11	=min(-55.50,3.5-A2-3.3166 (B2-max(0,kl0)))		
11.25	=min(-55.50,3.5-A2-3.3541 (B2-max(0,kl0)))		
11.5	=min(-55.50,3.5-A2-3.3912 (B2-max(0,kl0)))		
11.75	=min(-55.50,3.5-A2-3.4278 (B2-max(0,kl0)))		
12	=min(-55.50,3.5-A2-3.4641 (B2-max(0,kl0)))		
12.01	=min(-80,3.5-A2-3.4655 (B2-max(0,kl0)))		
12.175	-112		
30	-112		

Table C.2 – Short, Medium and Long PSD masks
defined in terms of kl0

[14] The function min(x,y) means x or y, whichever is closest to -∞

[15] The function min(x,y) means x or y, whichever is closest to +∞

Note: The effective range of kl0 is limited to 0 to 24. Values of kl0 lower than 0 do not result in a lower mask. Values of kl0 in excess of 24 do not result in an increased mask. Within these bounds any value of kl0 may be used.

Note: The data given in Table C.2 is available in electronic format [21]. In the event of any discrepancy between the data given in the spreadsheet [21] and that in Table C.2, the data in Table C.2 applies.

C.3.2   Dynamic PSD Mask Specification

Allow any dynamic configuration of parameters A1, A2, B1, and B2 in a range that meets the PSD mask as described in Table C.2 with A1=55, B1=21, A2=55, and B2=8 under the constraint that the normalised average (average defined mathematically in section 4.3.1) PSD imposed on the lines in the given distribution area (SLCP) is always below the average PSD mask as defined in Table C.2 with the average PSD mask having parameters A1=62, B1=21, A2=62, and B2=8.

If an operator only has one line at an SLCP, then this line shall conform to section C.3.1 due to the normalised average PSD constraint in C.3.2, which is only averaged across one line.

C.4   Test Specification

The test specification specified in section 6 applies using the resolution bandwidths specified in one of Table C.3, Table C.4 or **Error! Reference source not found.**.

Frequency Band	Resolution Bandwidth
100 Hz to 5 kHz	100 Hz
5 kHz to 1265 kHz	10 kHz
1265 kHz to 3745 kHz	1 MHz
3745 kHz to 5205 kHz	10 kHz
5205 kHz to 8495 kHz	1 MHz
8495 kHz to 12005 kHz	10 kHz
12005 kHz to 30005 kHz	1 MHz

**Table C.3 Resolution bandwidth for measuring against the
Short NTP mask**

Frequency Band	Resolution Bandwidth
100 Hz to 5 kHz	100 Hz
5 kHz to 895 kHz	10 kHz
895 kHz to 3745 kHz	1 MHz
3745 kHz to 5205 kHz	10 kHz
5205 kHz to 8495 kHz	1 MHz
8495 kHz to 12005 kHz	10 kHz
12005 kHz to 30005 kHz	1 MHz

**Table C.4 - Resolution bandwidth for measuring against the
Medium and Long NTP mask**

- End of Part C -

Part D (normative):
ANFP PSD Mask Definition for MDF EO

D.1   Introduction

This part of the ANFP specifies the PSD Mask that applies to transmission equipment connected to the MDF at an MDF site when that MDF is connected to cables routed directly to the NTP (i.e. without being routed via a SLCP) **and** where those cables are ***not*** in a cable sheath with any metallic access cables routed via a SLCP.

D.2   PSD Mask Specification

The specification of Part A applies.

It is for future study whether for these EO lines, an enhanced PSD Mask specification can be produced and agreed that would allow the use of higher frequencies than those allowed in Part A taking account that there is no SLCP for connection of transmission equipment. Such an enhancement would be backward compatible with this current Part D specification.

D.3   Test Specification

The test specification specified in section 6 applies using a resolution bandwidth defined in section A.3.

- End of Part D -

Part E (informative): ANFP PSD User Guide

E.1   Introduction

Information is provided in this part on the systems considered in the development of the ANFP and a review of some DSL technologies against it. The ANFP does not exclude specific systems; it excludes by implication: one may not install a system which does not conform to the masks at each of its line connection points. As noted at Section 5.1, it is the responsibility of the user to deploy equipment in operating in conformance with the ANFP and provide appropriate conformance certification.   It should be noted that where there are mechanisms defined in the international standards to use the xDSL associated management system to permit the network operator to reduce or shape the transmit PSD of a system. These can be used to make a standardised ANFP non-compliant system compliant.

Note: This document only considers transmission systems operating over the KCH access network. When private networks are connected to the KCH access network, signals from the private network transmitted on to the KCH access network need to comply with the ANFP. A separate document [29] discusses and gives guidance on this issue.

E.2   Line Categorisation

The line categorisations are set out in Part C of this document.

E.3   How Various Classes of DSL may fit the ANFP

The following table names the standardised systems which were used in the construction of the KCH ANFP versions, and which were intended to be admitted by design. This version of the ANFP is designed to accommodate equipment operating plan VDSL2 998ADE17.

Short Line	Medium Line	Long Line
POTS	POTS	POTS
ISDN Basic Rate Access	ISDN Basic Rate Access	ISDN Basic Rate Access
ADSL over POTS	ADSL over POTS	ADSL over POTS
64kbps AMI	64 kbps AMI	64 kb/s AMI
64 - 256 kbit/s 2B1Q	64 - 256 kbit/s 2B1Q	64 - 256 kbit/s 2B1Q
SDSL/SHDSL 64 - 2312kbit/s gross rate	SDSL/SHDSL 64 - 1160 kbit/s gross rate	SDSL/SHDSL 64 - 1032 kbit/s gross rate
ADSL2 (See notes below)	ADSL2 (See notes below)	ADSL2 (See notes below)
ADSL2+(see notes below)	ADSL2+(see notes below)	ADSL2+(see notes below)

Table E.1 - Standardised DSL Systems Admitted by Design

For example, the ANFP would exclude the following standardised systems from use on *any* KCH access network line ('Short', 'Medium' or 'Long'):

- A 1-pair 2.3 Mbit/s HDSL system using 2B1Q or CAP

- ADSL over ISDN

- Reverse ADSL (i.e. with the high bandwidth implemented in the customer to exchange direction). This means that ADSL is precluded from use on private circuits.

E.3.1 ADSL2 and ADSL2+

The ITU-T standards family G.992.1 [15], G.992.2 [25], G.992.3 [26] and G.992.4 [27] use the same frequency spectrum: ADSL2 systems may therefore be considered with ADSL systems. G.992.5 systems (ADSL2+) [7] use an extended frequency spectrum and requires separate consideration. Generally, the annexes to the standards specify the sub-carriers and their associated transmission power levels using a coherent Annex naming convention to designate the same area of concern and similar use of sub-carriers.

ITU-T G.992.x Annex	1-5	6-31	32-64	65-255	256-512*	ADSL G.992.1	ADSL2 G.992.3	ADSL2+ G.992.5
A	POTS	UP	DOWN	DOWN	DOWN	YES	YES	YES
B	ISDN	ISDN	UP	DOWN	DOWN	YES	YES	YES
C	TCM ISDN	UP	DOWN	DOWN	DOWN	YES	YES	YES
I	UP	UP	DOWN	DOWN	DOWN	N/A	YES	YES
J	UP	UP	UP	DOWN	DOWN	N/A	YES	YES
L	POTS	UP**	DOWN**	DOWN	DOWN	N/A	YES	NO
M	POTS	UP	UP	DOWN	DOWN	N/A	YES	YES

Use of tones applies to the non-overlapped PSD masks only

*   ADSL2+ only

** Not all tones are used

N/A Not Applicable

Table E.2 - ADSL Standard Annexes and Use of Tones

E.3.2 ADSL and ADSL2 Compliance

Tones shown in *red* indicate non-compliance. Summary of compliance to this ANFP is:

Annex	1-5	6-31	32-64	65-255
A	POTS		DOWN	DOWN
B	ISDN	ISDN		DOWN
C	*TCM ISDN*		DOWN	DOWN
I			DOWN	DOWN
J				DOWN
L	POTS		*DOWN*	DOWN
M	POTS			DOWN

Table E.3. ADSL2 v MDF (Downstream) ANFP Parts A and D

The higher launch limit of Annex L option exceeds the ANFP limit and thus is not supported without downstream spectrum shaping.

Annex	1-5	6-31	32-64	65-255
A	POTS		*DOWN*	*DOWN*
B	ISDN	ISDN		*DOWN*
C	*TCM ISDN*		*DOWN*	*DOWN*
I			*DOWN*	*DOWN*
J				*DOWN*
L	POTS		*DOWN*	*DOWN*
M	POTS			*DOWN*

Table E.4 ADSL2 v SDF (Downstream) ANFP

Annex	1-5	6-31	32-64	65-255
A	POTS	UP		
B	ISDN	ISDN	*UP*	
C	*TCM* *ISDN*	UP		
I	UP	UP		
J	UP	UP	*UP*	
L	POTS	*UP***		
M	POTS	UP	*UP*	

Table E.5 ADSL2 v Customer End NTE (Upstream) ANFP

Annex B: ATU-R PSD limits are non-compliant against all upstream masks.

Annex J: provides a family of PSD masks. PSD shaping is required for compliance to meet the appropriate line classification mask for the majority of line option combinations.

Annex L: Upstream Mask 1 and 2 PSDs exceed the permitted PSD and are not supported without appropriate PSD shaping.

Annex M: as per Annex J comment.

E.3.3 ADSL2+ Compliance

Summary of compliance to this document is:

Annex	1-5	6-31	32-64	65-255	256-512
A	POTS	UP	DOWN	DOWN	DOWN
B	ISDN	ISDN		DOWN	DOWN
C	TCM ISDN		DOWN	DOWN	DOWN
I			DOWN	DOWN	DOWN
J				DOWN	DOWN
L	N/A	N/A	N/A	N/A	N/A
M	POTS			DOWN	DOWN

Table E.6 ADSL2+ v MDF (Downstream) ANFP

Annex	1-5	6-31	32-64	65-255	256-512
A	POTS	UP	*DOWN*	*DOWN*	*DOWN*
B	ISDN	ISDN		*DOWN*	*DOWN*
C	TCM ISDN		*DOWN*	*DOWN*	*DOWN*
I			*DOWN*	*DOWN*	*DOWN*
J				*DOWN*	*DOWN*
L	N/A	N/A	N/A	N/A	N/A
M	POTS			DOWN	DOWN

Table E.7 ADSL2+ v SDF (Downstream) ANFP

Annex	1-5	6-31	32-64	65-255	256-512
A	POTS	UP			
B	ISDN	ISDN	UP		
C	TCM	UP			

	ISDN				
I	UP	UP			
J	UP	UP	UP		
L	N/A	N/A	N/A	N/A	N/A
M	POTS	UP	UP		

Table A4-5 ADSL2+ v Customer End NTE (Upstream) ANFP

E.4 VDSL and VDSL2 Compliance

E.4.1   VDSL Compliance with ANFP

The ANFP prohibits the use of VDSL from the exchange, even on short line lengths that have no sub-loops.

VDSL cannot normally comply with the ANFP Part B requirement to shape the downstream PSD for transmissions from cabinets, and so cannot normally be considered compliant with the ANFP. There are optional band plans for VDSL which could be deployed at such cabinets, however VDSL technology should be considered as obsolescent and for new deployments VDSL2 is much preferable in the UK.

E.4.2   VDSL2

The ITU standard for VDSL2 has now been approved as G.993.2 (2011-12)[19], for speeds up to 200 Mbit/s using bandwidths up to 30MHz. The profile compatible with ANFP compliance is AnnexB-998ADE17-M2x-A, enabling bit rates up to 100Mbit/s using frequencies up to 17.664 MHz. In order to be fully compliant with the ANFP a maximum PSD of -49.5dBm/Hz must additionally be imposed on this profile, which can be done though an additional standardised MIB parameter. Some other profiles or Annexes are likely to be compatible with the ANFP, but these would generally offer less capability than the AnnexB-998ADE17-M2x-A profile.

E.4.2.1   DPBO

The PSD shaping required to meet the requirements of Part B of the ANFP is supported through the definition of appropriate "MIB PSD Masks" which are described in section 7.2.1.1 of the standard.

The standard for the MIB itself that is used to set up appropriate MIB PSD masks is described in ITU-T Rec. G.997.1. The managed object is known as Downstream Power Back-Off – Shaped (DPBOSHAPED) and is described in section 7.3.1.2.13.

Nine parameters (DPBOEPSD, DPBOESCMA, DPBOESCMB, DPBOESCMC, DPBOMUS, DPBOFMIN, DPBOFMAX, DPBOLFO, DPBOMUS) need to be set up in the MIB to configure it correctly. Once this is done any value of CAL for ANFP use can be selected by choosing an appropriate value for another MIB

parameter, DPBOESEL. System vendors should be able to assist in setting these parameters correctly so that particular ANFP Part B masks are complied with.

E.4.2.2   UPBO

There are two modes defined in the ANFP that are applicable to VDSL2 UPBO. Guidance is provided for operators using the static mode, from section C.3.1 of the ANFP, in section 6.11.2.1 and for those using dynamic mode, from section C.3.2 of the ANFP, in section 6.11.2.2.

E.4.2.2.1   Static Mode UPBO

VDSL2 upstream signals are primarily subject to far end crosstalk (FEXT) as an interference source. At the time of writing they are the only upstream DSL signals that are limited in this way, all others being limited by the more severe near end crosstalk. Upstream VDSL2 upstream signals are highly likely to be coming from CPE that are at different ranges from a cabinet headend. If they are all transmitted at the same original level they will thus have very different levels by the time they reach the head-end. If this situation were allowed the more distant CPE would suffer unfairly from the FEXT from circuits that have CPE close to the cabinet. Upstream Power Back-Off (UPBO) is employed to make this situation more equitable, lowering the transmit power of the closer CPE to lower the FEXT they couple into distant CPE. The use of UPBO is mandated in section C.3.1 of the ANFP through the parts of the mask that are dependent on the kl0 value (those parts in the US1 band between 3.75 and 5.2 MHz and in the US2 band between 8.5 and 12MHz). kl0 is a measure of the loss of the loop between the customer and the cabinet hosting the SLCP. The greater kl0, the greater (higher) the allowed transmit signal levels. The amount of power back-off required for a given kl0 to comply with the ANFP is determined by the parameters A1=60, B1=21, A2=60, B2=8.

VDSL2 technology directly supports the UPBO required by the ANFP. This is done through the UPBOPSD CO-MIB structure. In this structure the values of:

- a′ for US1 should be set to be equal to A1=60 (2000 using the scaling defined in the MIB)

- b′ for US1 should be set to be equal to B1=21 (2100 using the scaling defined in the MIB)

- a′ for US2 should be set to be equal to A2=60 (2000 using the scaling defined in the MIB)

- b′ for US2 should be set to be equal to B2=8 (800 using the scaling defined in the MIB)

kl0 can be estimated by the modem itself if the CO-MIB value UPBOKLF is set to zero.

System vendors should be able to assist in setting these parameters correctly so that particular ANFP Part C.3.1 masks are complied with.

The accuracy of the estimation of kl0 by the DSLAM's modem is important for obtaining the correct degree of UPBO. CPs are urged to ensure that DSLAM modems used are able to estimate kl0 correctly so that the ANFP is complied with. Accuracy of kl0 estimation is a known issue as the VDSL2 standard doesn't mandate a method. In particular many DSLAM modems may have difficulty estimating kl0 accurately if there are bridge-taps on the loop plant, especially if those bridge-taps happen to cause notches in transmission within the applicable pass bands. Bridge taps are not likely to be present in the Openreach part of the sub-loop, but are likely to be present in customer wiring.

Work has progressed in the ITU to define a known strategy for modems to estimate kl0 that is likely to be more accurate, known as Alternative Electrical Length Estimation Method (ELE-M1), although the mechanism is optional. At the time of this writing, this mechanism is defined in G.993.2 (2006) Amendment 7, and is in the process of being incorporated into the overall revision of G993.2 (2011). CPs should consider requesting this option when deploying VDSL2 systems under ANFP section C.3.1. Alternatively the MIB

parameter UPBOKLF could be set to one, forcing the use of the kl0 value defined by MIB parameter UPBOKL, and this value could be set by some proprietary technique with appropriate accuracy.

E.4.2.2.2   Dynamic Mode UPBO

The dynamic PSD mask specification is defined in Section C.3.2 of the ANFP, which for VDSL2 systems only applies to upstream using UPBO. Dynamic PSD mask specification could be used with technologies other than VDSL2 as long as they are capable of dynamic line by line PSD control that meets the requirements. This section clarifies what it means to comply with the dynamic PSD mask specification, and provides some examples of compliant PSDs. There are two criteria which compliant systems must meet to use the dynamic PSD mask specification: a PSD mask constraint on every line (described in Section 4.2.2.2.1), and a normalised average PSD constraint which the ensemble of all lines at an SLCP must meet for each network operator (described in Section 4.2.2.2.2).

The PSD mask constraint allows some lines to transmit up to 5 dB higher power at some frequencies. However, the average PSD constraint mandates that other lines lower their power at those frequencies, such that the average PSD mask is 2 dB or more below the static mask. This allows some flexibility to dynamically optimize transmit spectra for particular service level targets under individual noise conditions.

E.4.2.2.2.1   Dynamic UPBO PSD Mask

Denote the PSD mask defined in Section C.3.1, on line n as $umask_n(f)$ dBm/Hz, where on line n, $kl0 = kl0_n$. The PSD mask that is actually complied with on line n is denoted as $amask_n(f)$ dBm/Hz. Compliance can be expressed in terms of $amask_n(f) - umask_n(f)$, and so the expression for this difference is simplified here.

Assuming that $\max(0, kl0) = kl0$ in Table C.2, the entries with UPBO can be written as

$$amask_n(f) = \min(LM, 3.5 - Ai - Bi\sqrt{f} - kl0\sqrt{f}) \text{ dBm/Hz}$$

with f in MHz and where i = 1,2, and LM is the Limit Mask defined in ITU-T G.993.2 for 998ADE17-M2x-A. The static mask $umask_n(f)$ is defined with A1 = A2 = 60, B1 = 21, and B2 = 8. The term $-kl0\sqrt{f}$ approximates the loop insertion loss, which is estimated by the transceivers to be approximately equal to the insertion gain of the loop expressed in dB, $kl0\sqrt{f} \sim= 10\log10(|H(f)|^2)$.

Dynamic PSD mask conformance specifies that each line meet a PSD mask in Table C.2 of the ANFP with A1=55, B1=21, A2=55, and B2=8. The difference between this and the static PSD mask specified in Section C.3.1 is that the values of A1 and A2 are 5 dB lower for the dynamic PSD mask than for the static PSD mask. This causes the dynamic PSD mask to be 5 dB above the static PSD mask, so that $amask_n(f) \leq umask_n(f) + 5$ dB, for all n. This is re-written

$$amask_n(f) - umask_n(f) \leq 5 \text{ dB}$$

Assuming that the UPBO is active so that $amask_n(f)$ is below the limit mask, LM, which is true for loop lengths up to about 850 m for US1, and for loop lengths up to about 300 m for US2:

$$amask_n(f) - umask_n(f) = 3.5 - Ai - Bi\sqrt{f} - kl0\sqrt{f} – (3.5 - 60 – [21 \text{ or } 8]\sqrt{f} - kl0\sqrt{f})$$

$$= 60 – Ai + ([21 \text{ or } 8] – Bi)\sqrt{f}$$

or,

For the US1 band (3.75 to 5.2 MHz): $amask_n(f) - umask_n(f) = 60 – A1 + (21 – B1)\sqrt{f}$

For the US2 band (8.5 to 12 MHz): $amask_n(f) - umask_n(f) = 60 – A2 + (8 – B2)\sqrt{f}$

The PSD mask that is actually complied with on line n is $amask_n(f)$, which can be defined by any values of A1, B1, A2, and B2 such that both the PSD mask and normalized average PSD constraints of Section 4.3.1

and Section C.3.2 are satisfied. However, some practical limits may be imposed by standards compliant systems; in ITU-T G.997.1 (G.ploam), parameter Ai ranges from 40 dBm/Hz to 80.95 dBm/Hz in steps of 0.01 dBm/Hz; and parameter Bi ranges from 0 to 40.95 dBm/Hz in steps of 0.01 dBm/Hz. Also, Ai = 40 dBm/Hz, Bi = 0 dBm/Hz is a special configuration to disable UPBO in the respective upstream band.

Both the mask constraint and the normalized average constraint can be stated in terms of $amask_n(f)$ - $umask_n(f)$. So, within the bounds of these constraints, the mask can be raised or lowered by a constant amount (60 – Ai) that can be different in each band. The mask can also be varied with respect to its slope in a way proportional to $\sqrt{f}$, specifically by $(21- B1)\sqrt{f}$ in the US1 band, and by $(8 - B2)\sqrt{f}$ in the US2 band; which again can be different in each band.
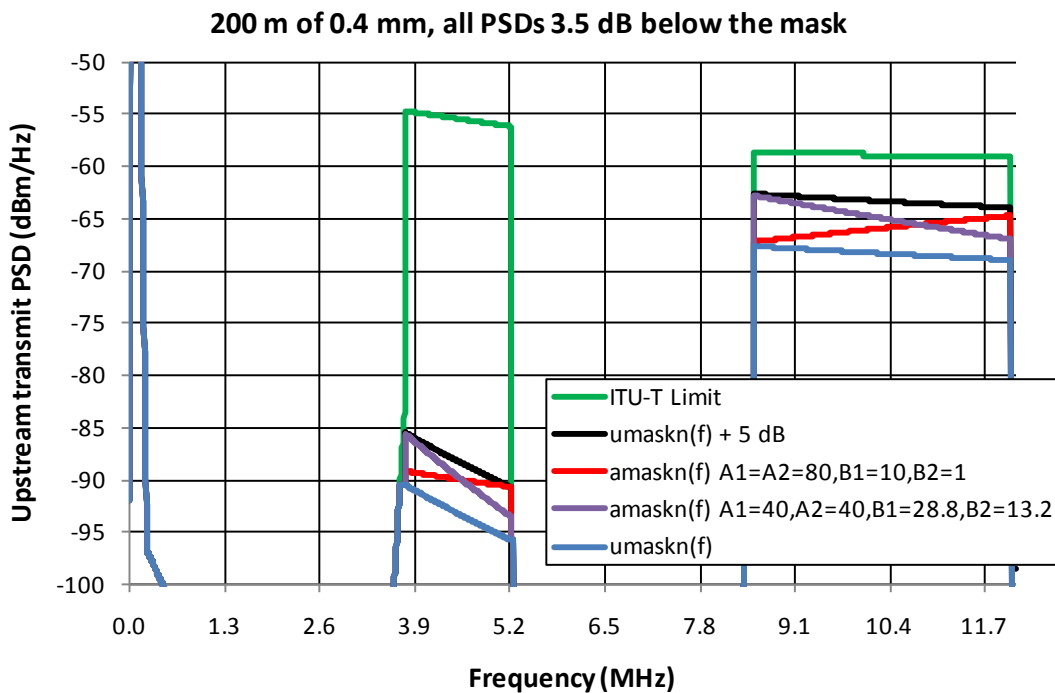

Figure 3. Some examples of actual transmit PSDs, *amask_n(f)*, that comply with the 5 dB maximum mask constraint on a 200 m loop. The black curve is the maximum mask. The red and purple curves show the two cases of √f shaping made possible by varying B1 and B2 (and A1 and A2).

Figure 3 shows a dynamic PSD mask with a flat PSD variation, only varying Ai, as $umask_n(f) + 5$ dB. It also shows cases with $\sqrt{f}$ shaping where B1 and B2 vary. The plot shows "PSD templates" which are 3.5 dB below the masks; these are about the most that a system can actually transmit while complying with a PSD mask and accounting for gain scaling (variation in gi values).

Operators should be careful to conform to the UPBO specifications. For example, the values of Ai and Bi shown in Figure 3 should not be used in general for all loop lengths, they are instead only applicable for defining a mask which is then to be used only for loops about 200 m long. Also, when line lengths change or when lines are added or removed from an SLCP, then dynamic PSD mask values may need to be recomputed in order to be compliant.

E.4.2.2.2.2   Normalised Average PSD Constraint

The normalised average PSD is defined mathematically in Section 4.3.1 of the ANFP. Compliance with the normalized average as defined in Sections C.3.2 and 4.3.1 depends on the actual PSD masks of multiple lines of each operator at an SLCP. From Section 4.3.1, the normalized average PSD constraint is

$$10 Log_{10}\left(\frac{1}{N} \sum_{n=1}^{N} 10^{(amask_n(f) - umask_n(f))/10} \right) \leq -2 \text{ dB}$$

for each network operator at that SLCP.

Using the equations in the previous section, in the above formula $amask_n(f) - umask_n(f)$ can be substituted by

$amask_n(f) - umask_n(f) = 60 - A1_n + (21 - B1_n)\sqrt{f}$ in the US1 band from 3.75 to 5.2 MHz, and $amask_n(f) - umask_n(f) = 60 - A2_n + (8 - B2_n)\sqrt{f}$ in the US2 band from 8.5 to 12 MHz.

Here the Ai and Bi values need to be indexed by line, n, since multiple lines are included in the normalised average PSD constraint. Two examples of sets of compliant PSD masks are shown.

Average PSD Example 1: A network operator wants to increase power one line that needs it, while the other lines are running with excess margin and can lower their power. The network operator has six lines at an SLCP ($N = 6$). One line uses a dynamic PSD mask with A1=55, B1=21, A2=55, and B2=8, which is 5 dB above the static PSD mask at all frequencies. The other five lines all use uses a dynamic PSD mask with A1=70, B1=21, A2=70, and B2=8, which is 10 dB below the static PSD mask at all frequencies. Then,

$$10 Log_{10}\left(\frac{1}{N} \sum_{n=1}^{N} 10^{(amask_n(f) - umask_n(f))/10} \right) = -2.14 \text{ dB} \leq -2 \text{ dB}$$

and the normalised average PSD constraint is satisfied.

Average PSD Example 2: A network operator wishes to employ a form of spectral shaping to boost the power on high frequencies on one line, while lowering the power at high frequencies on other lines. The network operator has 10 lines at an SLCP ($N = 10$). One line uses a dynamic PSD mask with A1=80, A2=80, B1=10, and B2=1; which is one of the cases shown in Figure 3. The other nine lines uses a dynamic PSD mask with A1=47.5, A2=47.5, B1=28.8, B2=13.2; which uses the same B1 and B2 as the other case shown in Figure 3, but with 7.5 dB less power in the US1 and US2 bands.

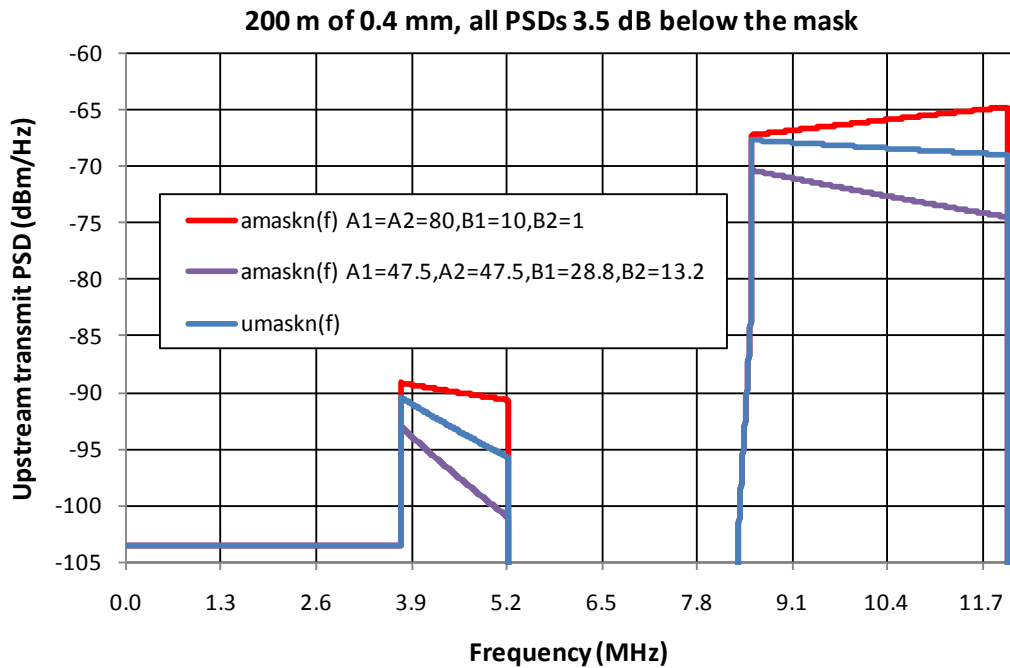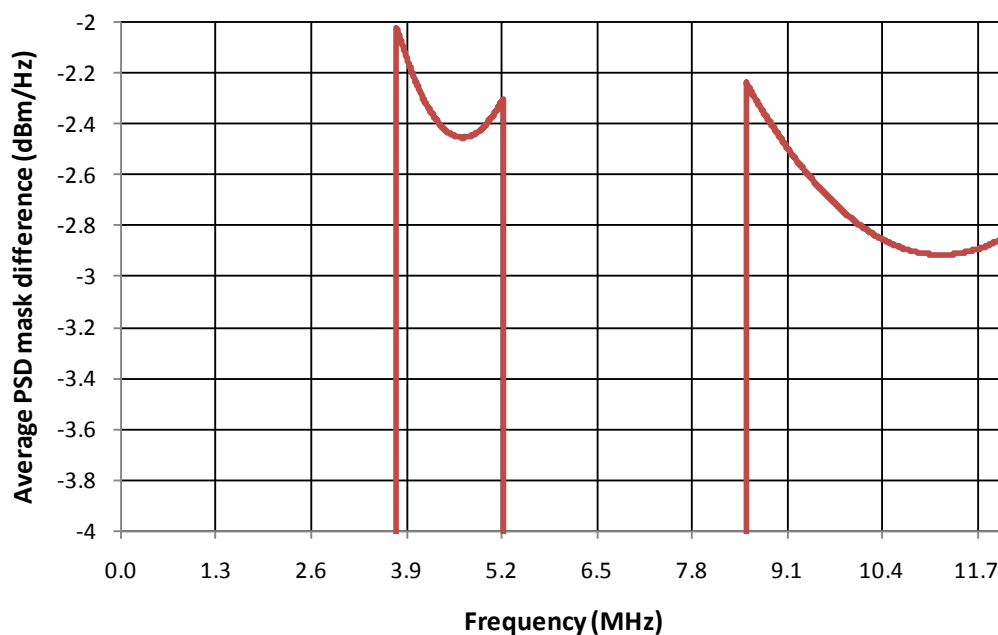**Figure 4. The PSDs used in Average PSD Example 2**

Figure 5. The Average PSD of Example 2

Figure 5 shows the average PSD of Example 2, $10Log_{10}\left(\dfrac{1}{N}\displaystyle\sum_{n=1}^{N}10^{(amask_n(f)-umask_n(f))/10}\right)$, which is seen to be

below -2 dB at all frequencies and so the normalised average PSD constraint is satisfied.

The constraints on dynamic UPBO parameters in the US1 band are independent of the constraints on dynamic UPBO parameters in the US2 band. So, the US1 and US2 bands could be optimized separately with different dynamic UPBO values in each band.

- End of Part E –

History

Document history		
Issue 1	January2003	First issue
Issue 2	September 2006	A revision of ANFP, Issue 1 to accomodate ADSL2+ deployments.
Issue 3 (V3.1.1)	March 2012	A revision of ANFP, Issue 2 introducing an SLCP with associated masks to accommodate plan VDSL2 998ADE17 and include frequencies up to 17MHz.